FERTILITY TRANSITIONS AND CHILDREN'S SCHOOLING IN SUB-SAHARAN AFRICA: DILUTION, DIVIDENDS & AGGREGATION

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Contemporary demographic transitions in sub-Saharan Africa present both an opportunity and motivation to re-examine the relationships between fertility transitions and schooling. In theory, fertility transitions have the potential to affect schooling opportunities. At the individual (micro) level, the dilution hypothesis proposes that declines in sibsize lead to increased investments in each child. At the national (macro) level, the dividend theory follows a similar logic, whereby improvements in the youth dependency ratio translate into gains in the total resources available for children. While both of these theories present cogent rationales, their empirical estimation faces a number of conceptual and methodological challenges. For the dividend argument, it is unclear how changes in fertility behavior at the national level are transformed into gains in schooling. The dilution hypothesis faces limitations regarding causal estimation and the inability to transpose micro-level estimates to macro-level inferences.

Given this background, this dissertation makes three main contributions. First, it conceptually clarifies how the schooling dividend is produced while also estimating the empirical gains in school quality that have been enabled by recent improvements in age structure. Second, it proposes and applies a new approach to examine the issues of endogenity in the sibsize schooling relationship. Last, it uses a decomposition framework that helps aggregate the micro-level effects of sibsize to the national level, while also appraising the influences of transitions relative to other socioeconomic changes. Overall, findings suggest the continued importance of fertility transitions for children's' schooling in sub-Saharan Africa.

BIOGRAPHICAL SKETCH

Sarah Giroux attended Dryden High School, Dryden, NY. In 1999, she entered Cornell University and dual-majored in International Agriculture & Rural Development and Development Sociology. In Spring 2003, she graduated summa cum laude with a Bachelors Degree. She entered the Development Sociology M.S./Ph.D. program in the Fall of 2003 and completed her Master's thesis, *Rural Parentage and Labor Market Disadvantage in a Sub-Saharan Setting: Sources and Trends*, in 2006. Her research has been published in a variety of journals, including *Rural Sociology* and *Studies in Family Planning*.

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CHAPTER 1.
INTRODUCTION

"The fertility transition has a dominance in demography possessed by no other theme. Its study is largely responsible for the growth of demography as a discipline over the last half-century"

(Caldwell 1997, p. 803).

1.1 Fertility transitions in sub-Saharan Africa

World population is expected to increase from 6.7 to 9.2 billion between 2007 and 2050. To put it in perspective, the size of this addition is equal to the total world population in 1950. The implications of this great expansion are of concern to researchers and policymakers alike, especially as the bulk of the growth will be absorbed by less developed areas of the world, where population is expected to swell from 5.4 billion in 2007 to 7.9 billion in 2005 (UN 2006). Of particular concern is how substantial gains in population size will play out in sub-Saharan Africa, an area that refers to Eastern, Middle and Western Africa. While home to 150 million people in 1950, the population is expected to reach one billion by 2025. Currently, these three regions are home to 72 percent of the continent's population, which is expected to rise to 80 percent by 2050 (UN 2004). This rapid and massive expansion of national populations is generally expected to present a critical challenge to the region's future social and economic development.

The bulk of the population growth in sub-Saharan Africa stems from two primary drivers: First are the persistently high levels of fertility. Between 1975 and 2010, the global total fertility rate dropped from 4.47 to 2.55 children per woman. However, this average masks substantial heterogeneity among regions. While more developed regions, which have already marched through their demographic transitions, experienced a decline in total fertility rate (TFR) from 2.13 to 1.60 during this period, the TFR of less developed regions only declined from 5.41 to 2.75. Further, within less developed areas, sub-Saharan Africa remains an exceptional case, with a TFR of 6.72 in the 1970s that only fell to 4.67 by 2010 (UN2006). A second driver of growth in sub-Saharan Africa is the young age structure that results from high fertility levels and improvements in child survival. In 2006, 44 percent of the population of sub-Saharan Africa was under the age of 15. This compares to 30 percent in Latin America and the Caribbean and 16 percent in Europe (Ashford 2007). This young age structure means that, even if fertility were to decline immediately, a large number of children are soon to enter their childbearing years and this will sustain the momentum of population growth for the next few decades.

The addition of millions of citizens clearly poses a challenge to development. Achieving low fertility in the region is critical to curb growth, reduce strains on resource-strapped governments, and improve overall economic conditions. While fertility is declining -projected at 3.9 by 2020- the large population base means the addition of a significant number of people (UN 2006). The extent to which this projected decline comes to pass will depend on current economic conditions and policy. The fact that sub-Saharan Africa has not yet completed the demographic transition makes this a timely moment to investigate the socioeconomic implications of fertility declines in this region. A central concern in demography has been if, and how, declines in fertility translate into improvements in socioeconomic well being. Fertility declines have the potential to generate socio-economic benefits for families and nations. At the family level, resource dilution theory (Blake 1981) proposes that declines in number of children per family, everything else constant, results in an increase the average amount of resources available per child. The story at the national level is similar: fertility declines lead to a change in the age structure, whereby the proportion of working age adults to children improves. As a result, nations are able to raise their investments towards the well-being of children and reap "dividends" from fertility declines (Bloom, Canning & Sevilla 2003).

The possibility of a demographic windfall from fertility transitions is a timely opportunity for a continent striving to achieve its Millennium Development Goals. Since the 1960s, the region's economic growth has been constrained by an assortment of factors, including "the legacy of colonial rule; heavy dependence on a small number of primary exports; problematic internal politics characterized by authoritarianism, corruption and political instability; economic policies of protectionism, statism, and fiscal profligacy; and deep ethnic divisions." (Bloom et al. 1998). Between 1996 and 2005, the proportion of people living on less than $1 per day in Sub-Saharan declined only marginally, from 58 to 51 percent (Chen & Ravillion 2008). Moreover, as a result of a high population growth rate, the actual number of poor people living in the region doubled between 1981 and 2005 (Chen & Ravillion 2008). According to a recent report on the region's status regarding the Millennium Development Goals, while "advances have been made in social indicators, such as net primary education enrollment, childhood immunization, stemming the spread of HIV/AIDS and tuberculosis and gender empowerment … progress in the key areas of poverty reduction, employment, and most health-related goals remains disappointing." (UNDP 2010, p. 84).

1.2 Schooling in sub-Saharan Africa

Given this context, the time is apposite for an investigation of the role of fertility transitions for children's wellbeing. While an analysis of children's well being could focus on a range of outcomes such as child health, nutrition, or mortality, children's schooling is of particular relevance. Over the past two decades, the region's commitment to improving children's education has been crystallized in the United Nations Millennium Development Goal (MDG) II, which seeks to "*ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling*" (UN 2008). While significant global progress has been made towards this goal- with net enrollment ratios rising from 54 of 71 percent between 1991 and 2006- sub-Saharan Africa lags behind other major regions. Currently 25 percent (32 million) of the primary school age population is out of school, representing nearly 45 percent of the global out-of-school population (UNESCO 2010). The region also has the world's lowest rate of secondary school attendance (34 percent) (UNESCO 2010). Even with rising rates of enrollment, 28 million pupils drop out of school each year (UNESCO 2010).

The case for an emphasis on schooling transcends the simple fact that the region lags behind its global counterparts and may not meet MDG deadlines. Schooling is also important given its long-term and global ramifications. Governments that invest in schooling foster the creation of educated workforces that are "more skilled, more adaptable, and more entrepreneurial" (NRC 1986). In the US, 42% of the growth in GDP between 1929 and 1957 was driven by gains in schooling (Denison 1962). Yet, in SSA marginal past investments in education have resulted in the fact that 38% of the working age population of cannot read or write (UNESCO 2010). Gains in schooling are also associated with a reduction in gender inequalities, declines in infant and child mortality, and improvements in child nutrition (UNESCO 2010). Understanding the determinants of schooling is also increasingly important in a region where the competition for schooling has intensified in the light of asymmetric urban transitions and high urban unemployment (Buchmann 2002; Giroux 2008; Lloyd and Gage-Brandon 1994).

Thus, current fertility transitions in developing countries will likely affect long-term prospects for socioeconomic development, as the transition-related gains in human capital among today's children spill over into adulthood and the next generation (Bloom, Canning & Sevilla 2003; Mason & Lee 2004). Whether sub-Saharan Africa fully takes advantage of fertility declines will depend, at least partially, on insights generated from policy-relevant research that clarifies the nature of transitional gains. Yet, despite the fact that the relationship between fertility transitions and schooling are some of the seemingly most intuitive trends in demography, closer examination reveals unresolved conceptual and methodological complexities.

Past research suggests that the process of family formation has implications for both individual families and the broader society:

"having children may generate benefits or costs for society, which may be either captured within the family or spill over and influence the welfare of other members of society. If these benefits minus costs borne by individuals outside of the family are substantial, society has a stake in private reproductive behavior. If the balance of benefits minus costs is negative, society may subsidize the adoption and use of birth control, for example; if the balance is positive, society may subsidize parent costs related to child health and schooling, for example. " (Schultz 2005, p.2).

Yet despite the recognition that the fertility-schooling relationship plays out at both the individual and societal levels the bulk of recent scholarship has focused on micro-level relationships. While this focus is warranted by concerns over empirical rigor, it has yet to: (1) overcome all the methodological challenges plaguing micro-level analyses; (2) incorporate the interplay between micro and macro level processes, or (3) account for the specific influences that macro-level processes associated with changing fertility can have on national schooling levels. This dissertation examines three broad questions about the effects of fertility transitions on schooling via macro-level changes in age structure (dividend), via micro-level changes in sibsize (dilution) and via cumulative changes at both the micro and macro-levels (aggregation). Using a mix of conceptual and empirical innovations, the broad questions explored in this dissertation are as follows:

1. **Dividends:** To what extent do fertility transitions, via changes in age structure, affect changes in schooling?
2. **Dilution:** Is there a relationship between sibsize and schooling, and to what extent can this relationship be considered causal?
3. **Aggregation**: How can we use micro findings of the effect of sibsize on schooling to estimate macro level schooling gains?

1.3 Research questions

1.3.1 Dividends

The first issue tackled here is to develop a strategy to understand how fertility transitions impact schooling at the national level. Instead of focusing on estimating the impact of sibsize on schooling outcomes for individual children, the tack here is to quantify the national level gains that are associated with the more favorable age structure generated by fertility declines. While the notion of a demographic dividend is well documented, nearly all research has focused on quantifying macroeconomic dividends in terms of savings, economic growth, and poverty reduction (Birdsall, Kelley, & Sinding 2001; Bloom, Canning, & Sevilla 2002; Greene & Merrick 2005; Mason & Lee 2004). Moreover, most research has depended on macro-level regressions. Here I use a decomposition approach and data from the World Bank (2010) to estimate how changes in age structure drive changes in educational quality both across world regions and within sub-Saharan Africa.

1.3.2 Dilution

Much of the micro-level literature on the sibsize-schooling relationship has focused on the issue of causality. The problem boils down to a concern that the estimates of the relationship between sibsize and schooling do not reflect a true casual relationship, but are jointly determined by parental reproductive preference and their propensity to trade quantity (large sibships) for quality (better educated progenies). To put it more simply, when parents decide how many children to have (quantity) they are also deciding the level of resources that will be allocated to each child (quality) (Becker 1993; Becker & Lewis 1973). In an effort to improve estimates, the bulk of the literature on the sibsize schooling relationship has used methodological innovations- such as the use of time-varying covariates, controlling for clustering & fixed effects of families, or, most predominately, the use of instrumental variables. Research in this vein has used instruments such as miscarriages, twin births, sibling sex composition (Angrist, Lavy & Schlosser 2005; Black et al. 2005; Conley & Glauber 2005; Maralani 2008; Rosenzweig & Wolpin 1980; Rosenzweig & Zhang 2006), as these instruments represent potential exogenous shocks fertility.

While sensible in theory, the use of instruments in this research has conceptual and practical problems that limit its application, and some of these limitations are discussed in more detail in the following chapters. The third set of analyses in this dissertation takes a new approach to evaluating the presence of a causal relationship between sibsize and schooling. Using event-history data collected in Cameroon in 1999, I proceed in two steps. First, I determine whether there is any evidence of a significant relationship between sibsize and schooling, after considering methodological issues associated with time-variation in sibsize, clustering, fixed effects, and historical and economic trends. If a significant relationship is evident, instead of using any of the classic instruments used in previous studies, I then proceed to examine the etiology of school dropout and the extent to which it suggests a causal relationship between sibsize and dropouts. Specifically, when examining the reasons why children drop out of school, do children from larger families tend to drop out disproportionately because of lack of money? The logic behind this analysis is that, if sibsize and schooling were not *causally* related (i.e., if the association between sibsize and schooling merely reflected an endogenous preference), children from large and small families should be equally likely to drop out due to a lack of money. A finding, however, of a significant relationship between sibsize and dropout due to lack of money would support for the dilution hypothesis and the argument of a causal relationship.

1.3.3 Aggregating the micro and macro effects

The last issue addressed in this dissertation stems from the need to translate micro level estimates, with all of their statistical power and rigor, into findings that can speak to the macro level concerns of policy makers. For example, a study that uses advanced regression techniques to estimate that each additional sibling reduces enrollments by .10 is scientifically interesting and important. However this micro-level estimate alone cannot effectively inform our understanding of the dividend production process at the national level. Research is therefore needed to address the ecological discrepancy between the dilution argument- which tends to rely on micro-level cross sectional data- and the need to understand the macro historical relationship between fertility transitions and schooling. The bulk of the work on the dilution hypothesis has used findings from cross-sectional comparisons of children with different sibsize to infer the effect of change in family size. Drawing such inferences is problematic.

Moreover, to paint an accurate macro-level picture, one needs to consider the distributional aspects of the fertility transition. If, as in the case of Latin America, "*the small upper income groups have the largest proportionate reductions, the mean levels of child health and education would be expected to decline, other things being equal, even though* *there are rising expenditures per child by those groups in which fertility declines*." (NRC 1987, p. 57) Some research (Knodel & Wongsith 1991; Knodel et al. 1990) has sought to address this issue, by accounting for how fertility transitions affect the distribution of children across family sizes, then estimating the micro-level effects of sibsize on schooling, and aggregating these schooling outcomes while considering the distribution of children across family sizes. However, the use of this approach has been limited and research has tended to focus instead on methodological advances to improve micro-level estimates.

The second set of analyses in this dissertation uses micro-level Demographic Health Survey (DHS) data from nine sub-Saharan countries. It applies an aggregation method to understand the socio-demographic drivers of recent trends in schooling attainment in sub-Saharan Africa. This approach capitalizes on the strength of micro-level data estimation, but also accounts for the possibility of uneven fertility declines across socio-economic (SES) groups and translates the findings to infer their macro level implications. The aggregation, and associated decomposition method, makes it possible to estimate the complementary contributions of demographic transitions, changes in the distribution of children across various SES groups, and broad-based national policy.

1.4 Structure of the dissertation

The rest of this dissertation proceeds as follows: Chapter 2 presents the theoretical framework, focusing on the dilution and dividend theories, and summarizes previous findings on the relationship between fertility transitions and children's' schooling. Chapter 3 provides an overview of current methodological challenges as well as a description of the data used in the analyses. Chapter 4 examines the macro-level relationship between demographic transitions and schooling by using World Bank country level data to estimate the national schooling dividends associated with changes in the age structure of a population. Chapter 5 focuses on the dilution hypothesis and uses event history data from Cameroon to evaluate the causal connection between changes in sibsize and schooling dropout. Chapter 6 presents findings from an aggregation analysis, which uses micro level data combined with a decomposition method to estimate the how national level changes in school enrollments are driven by demographic transitions, changes in the distribution of children across various SES groups, and broad-based national policy. The conclusions, caveats and future directions are discussed in Chapter 7.

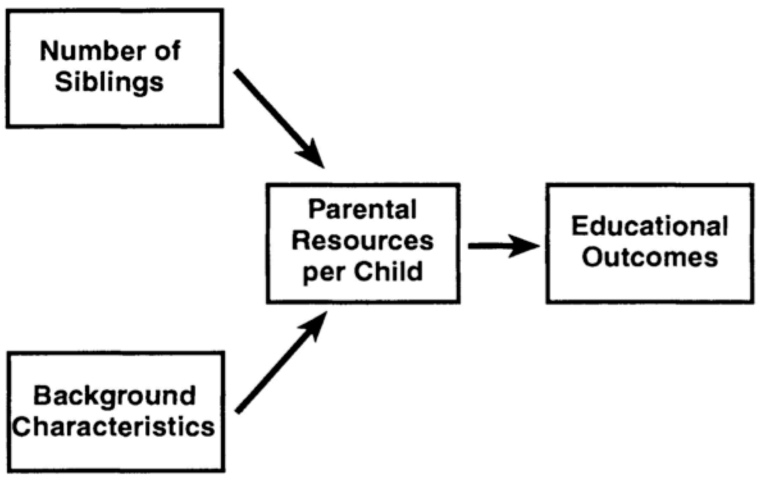
CHAPTER 2.
THEORETICAL FRAMEWORK & PREVIOUS STUDIES

To understand the connections between fertility transitions and schooling outcomes, this chapter first provides an overview of key theories linking the two concepts. As the bulk of previous literature examines these connections at the micro-level, via the "dilution hypothesis," the review begins here. This is followed by an assessment of important findings and potential limitations associated with the dilution hypothesis. The review then continues with a synopsis of the theoretical underpinnings of the fertility-schooling linkage at the macro-level, as well as the relationship between the dilution argument and the "dividend" hypothesis. The chapter concludes with a justification for a focus on schooling.

2.1 The Dilution Hypothesis

As the global demographic transition unfolds, demographic research in developing countries has perceptively shifted towards understanding the consequences of this behavior. In her 1981 address to the Population Association of America, President Judith Blake brought the sibsize-schooling issue to the forefront. Using data from the United States, she found support for the "dilution hypothesis" or the notion that "*the more children, the more these resources are divided (even taking into account economies of scale) and hence,* *the lower the quality of the output*" (Blake 1981, p. 422). Essentially, parental resources are finite and are diluted by the number of children, and most dilution models are conceptually mapped as send in Figure 2.1.

Figure 2.1 Illustration of the resource dilution hypothesis (Downey 1995)



It is important to note here that the idea of dilution was not entirely new. Economist Gary Becker (e.g. Becker 1964; Becker & Lewis, 1973) had earlier proposed that parents who have more children commit less of their time and resources to each of their children. Under this framework, parents decide how to invest in both the "quantity of children" and the "quality of children". He argued that declines in family size would increase human capital investments per child and improve the educational, health and consumption opportunities of individual children. Blake further refined this hypothesis and proposed that the idea of parental resources per child did not only pertain to economic capital, but to a wide range of factors. Blake (1981) contends that parents "resources" can be thought of in three categories, including: *settings*, that is, the physical objects and cultural milieu that make up the home (including computers, books, music, art, etc.); *treatments*, which include factors such as parental aspirations, encouragement and tutoring; and *opportunities*, or chances to "do things" in the outside world (such as travel, visiting museums, etc.).

Previous research in a variety of settings had found that sibling size (sibsize) affects cognitive ability (Marjoribanks 1974) and education outcomes/performance (Blau & Duncan, 1967, Featherman & Hauser, 1978, Sewell, Hauser, & Wolf 1980). However, Blake's work was seminal in taking these prior findings and moving sibsize from a standard control variable to a concept with substantive relevance. In her 1981 paper, Blake modified Sewell's Wisconsin Model and tested the relationship between sibling size and college plans among boys. The findings led to her conclusion that "*in general, research documents the unfavorable consequences for siblings of high fertility, even in a country that is (at least for whites) as socially economically, and politically advantaged as the United States*" (Blake 1981, p. 421).

Blake continued her work testing the dilution hypothesis, and published *Family Size and Achievement* in 1989. Using multiple U.S. data sets (General Social Surveys, 1972 to 1986; Occupational Changes in a Generation, 1962 and 1973; Growth of American Families, 1955 and 1960; National Fertility Study, 1970; High School and Beyond, 1980; and Health Examination Surveys, 1960 to 1970), she again found negative relationships between sibsize and educational attainment (Blake 1989). Moreover, in models that including other standard predictors of attainment (sex, race, family income, family structure, parents education and occupation) only father's education had a consistently larger impact on years of educational attainment than sibsize (Downey 1995; Blake 1989).

Other scholars investigating the sibsize-educational attainment relationship in the United States have found similar results. Net of standard socioeconomic controls, Steelman and Powell (1989) find a negative relationship between sibsize and parental financial support for college. Moreover, they find that children from larger families are more likely to cite financial pressures as a reason for not attending college (Steelman & Powell 1989). Mare and Tzeng (1989) find that the effect of sibsize on young men's completed educational attainment is equivalent or more influential that that of paternal education, urban residence, race, region, family income or fathers SEI. In his 1995 paper, Downey finds confirmation for the dilution hypothesis, but more precisely specifies the nature of the relationship. He concludes that while economic resources are subject to a 1/x dilution form (with X being the number of children in the household), other educational resources (such as computers, books, etc.) are subject to a threshold effect, with the addition of an extra child past a critical threshold having no further dilution effect. Kuo and Hauser (1997) use data from the Wisconsin Longitudinal study and conclude that sibsize has important effects on educational attainment.

While most of the initial work on the dilution hypothesis centered in the United States or Europe, scholars became interested in applying the resource dilution hypothesis to study the effect of sib-size in developing country contexts. Given the fertility declines occurring in many developing regions, evidence of a negative relationship could herald promising growth in enrollments and an exciting development prospect. In Thailand, Knodel et al. (1990) and Knodel and Wongsith (1991) found that children from smaller families are more likely to go on to both lower and upper secondary school than those from a larger family. Indeed, the effect of family size is so substantial that "*a child from a family with one or two children is more than five times as likely to enter lower secondary school as a child from a family with six of more children*" (Knodel et al 1990, p. 41). Negative associations between sibsize and schooling are also evident in the Dominican Republic and Philippines (Montgomery & Lloyd 1997), Malaysia (Pong 1997), and Taiwan (Parrish & Willis 1993).

2.1.1 Findings In International Settings

Although the inverse relationship between family size and schooling has been described as "one of the most consistent findings in the status attainment literature"(Downey 1995:746), the dilution hypothesis has been challenged on multiple grounds. Part of this challenge stems from the numerous studies in developing contexts finding either no or positive associations between family size and schooling.

In sub-Saharan Africa, early work by Gomes (1984) in urban Kenya found that children from small families achieved an average of 6.9 years of schooling while those from larger families attained 8.5 years, a finding that held even when controlling for socioeconomic status, sex and age. Chernichovsky (1985) found a similar positive association between family size and schooling in rural Bostwana. Later work suggested more nuanced findings. In Ghana, Lloyd and Gage-Brandon (1993) found that the negative association between sibsize and schooling only impacted girls. Montegomery and Kouame (1993) reported a negative association in urban areas of Cote d'Ivoire and a positive association in rural communities, and Eloundou-Enyegue and Williams (2006) find a similar relationship in Cameroon. Buchmann (2000), meanwhile, found no evidence of a relationship between sibsize and schooling in Kenya. Using Demographic and Health Survey data from Cameroon, Kenya, Malawi, Namibia, Niger, Tanzania, and Zambia, Lloyd and Blanc (1996) find significant negative relationships only in Kenya and Namibia.

In other regions, Ahn et al. (1998) found that the negative relationship between sibsize and schooling in Vietnam is no longer significant upon adding controls for socioeconomic status. Considering various ethnic groups in peninsular Malaysia, Sudha (1997) finds that there is no effect of family size at any level of schooling among Malays, but that there is a significant negative association between sibsize and the odds of completing primary schooling for Chinese and Indians. However, even among Chinese and Indians, this there is no significant net effect on secondary school. Pong (1997) finds evidence for the dilution hypothesis but it is only over time that *"Malay children with many siblings apparently faced increasing competition for family resources, as compared to those with few siblings*" (Pong 1997, p. 238). In Indonesia, Maralani (2008) similarly finds a shift from a positive association in the early cohorts to a negative association in more recent decades. Eloundou-Enyegue and Williams (2006) also find evidence of a negative association only appearing in later cohorts.

Such conflicting findings may seem surprising given the inherent simplicity of the dilution hypothesis- "*couples with larger progenies divide their resources among many children, and even allowing for economies of scale and fixed costs, this dilution implies fewer material and non material resources available per child*" (Eloundou-Enyegue & Williams 2006, p. 27). Thus the inconsistency in these findings raised the need for conceptual and methodological re-consideration.

2.1.2 Contextual Dependency

On the conceptual side, many scholars suggested that the systematic variation in findings might be related to contextual forces, at the national and family levels, that can vary across counties[1] (Desai 1995; Lloyd 1994). At the national level, overall levels of

[1] While this critique is useful, it should be noted that Blake recognized the relevance of context in her earlier work. She proposed that the sibsize-schooling relationship would be

development, stage in the demographic transition, and national educational policies are critical in determining the direction and magnitude of the sibsize effect (Lloyd 1994). With regards to level of development, Lloyd (1994) notes that schools and educational infrastructure must be present in order for parents to even begin to make decisions about child investments. Essentially "*the issue of sibling competition only becomes relevant if a moderate addition to parental resources directed toward the child is sufficient to bring about substantial improvement in child-well being*" (Lloyd 1994, p. 186). Moreover, decisions about investments are typically related to the educational services available and children's' future opportunities in the labor market, which both tend to be dependent on broader development trends (Lloyd 1994). These theoretical proposals about the relevance of development tend to be supported by research, which shows that the negative relationships between sibsize and schooling are more likely to occur in urban than rural settings in Africa (Chernichovsky 1985; Eloundou-Enyegue & Williams 2006; Gomes 1984; Montgomery & Kouame 1993;) and less likely to be observed in more developed countries of Southeast Asia (Knodel et al. 1990; Knodel & Wongsith 1991; Pong 1997). Further evidence is in historical studies across generations, which show the presence of sibsize effect emerging in later generations at more advanced stages of development (Eloundou-Enyegue & Williams 2006; Lloyd 1994; Maralani 2008; Pong 1997).

Related to stage of development, a countries stage in the demographic transition may additionally shape the nature of the relationship between sibsize and schooling. As countries progress from high fertility, high mortality to low fertility, low mortality regimes, the "*adoption of deliberate fertility regimes has implications not only for the relationship between fertility and family size but also for the parental motivation to invest in children* (Lloyd 1994, p. 189). Thus, by moving from "family building by fate" to "family building by design" parents are better able to control their family size and more likely to invest in children, as these children are increasingly likely to survive long enough to benefit from

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mediated by the level of support for children from outside the nuclear family. Using examples from the United States, she found that the relationship between sibsize and educational attainment was weaker among Catholics than Protestants, as the larger Catholic community tended to provide more support to its members, including assistance with tuition in Catholic schools (Blake 1989).

parents investments (p.189). Combined with advances in socioeconomic development, declines in fertility and infant mortality create a context where parents are increasingly interested in investing in children, and under these conditions a negative relationship between sibsize and schooling in more likely to emerge. In Thailand, which underwent a rapid demographic transition combined with relatively strong economic growth, Knodel and colleagues (Knodel et al. 1990, Knodel & Wongsith 1991) find evidence of a strong negative association between sibsize and entry into lower and upper secondary school.

With regards to national policy, in countries where education is subsidized by the state, costs of schooling are low, schooling is compulsory and attendance enforced, then the dilution effect will be less apparent, as the costs of each child's schooling are spread beyond the individual family (Lloyd 1994; Eloundou-Enyegue 2006). As noted above, in Malaysia, Sudha (1997) found that government policy, which provided educational support for ethnic Malays resulted in no negative impact of family size on educational attainment, while ethnic groups that received little government support for schooling (Chinese and Indians) were subject to a negative relationship between sibsize and schooling. Lu and Treiman (2005) examining a series of dramatic policy changes in China, find that periods of declining competition correspond with declines in the effect of sibsize on educational attainment. In Hong Kong, Post and Pong (1998) posit that the diminishing effects of sibsize that occurred during the 1970s were tied to the massive expansion in free schooling during this period.

At the family level, and particularly in the case of sub-Saharan Africa, factors including the extent of sibling support, the nuclearity of the family, and the extent (and direction) of child fosterage mediate the relationship (Montgomery, Kouame, & Oliver 1995). Gomes (1984) finding of no relationship between sibsize and schooling makes more sense given the prevalence and importance of sibling support chains in Kenya. Here, education of the eldest child in the family was often halted so that they could enter the labor force and remit earnings back to the household, which in turn could be used to support younger members schooling. In Taiwan, Parrish and Willis (1993) similarly find that *"a large number of children in the family may lead not to a universal resource dilution but to improved opportunities for the late born"* (p. 868). Thus, places with of high fertility, and where children can serve as resource boons, are more likely to exhibit a positive association between sibsize and schooling.

While previous research tended to assume a bounded nuclear family unit with fixed family resources, Caldwell and Caldwell (1987) suggest that sibsize will have little impact on educational attainment under circumstances where educational costs are spread among a wider array of relatives. While the negative association between sibsize and schooling may be more prevalent in an industrial setting with nuclear families, it's less likely to be observed in societies where extended family living arrangements are more typical. Beyond spreading costs generally, the practice of child fosterage plays a particularly important role. Ainsworth (1992) finds that child fosterage can serve as a family level mechanism through which the costs of children can be spread among a larger network of relatives[2]. The practice of fosterage is particularly widespread in West Africa and it *"enables parents to escape some of the costs of schooling that might otherwise, given liquidity constraints, make it necessary that fertility be reduced if the children are to be property educated*" (Montgomery, Kouame & Oliver 1995, p. 15). Lloyd and Desai (1992) find that in many sub-Saharan countries, children spend a substantial portion of their childhood years living away from their mothers: 18% in Ghana, 16% in Senegal, and 12% in Mali. Between 1998 and 2000, 27% of households in rural Burkina Faso either sent or received a foster child, and these fostered children spent an average of 2.75 years away from their parents (Akresh 2005). In South Africa, Lu (2007) finds a negative association between sibsize and schooling among whites, but no effect for blacks, who are more likely to reside in an extended family arrangement.

Evidence additionally suggests that families make an effort to foster children into households where with greater resources (Blanc and Lloyd 1990). In Ghana, Blanc and Lloyd (1990) find that both very young and older women are most likely to live with foster children, as they have limited responsibilities to their own children at these stages in their life course. In Burkina Faso, Akresh (2005) randomly sampled households and then

[2] Fosterage may also have a secondary impact on the sibsize-schooling relationship (Caldwell & Caldwell 1987; Lesthaeghe 1989; Stokes 1995) in that poor families who are able to defray their own child rearing costs by sending children to live with other families have little incentive to reduce their family size.

identified families who had received foster children and the families who had sent them. After linking these families, he was able to show that fostered children experienced significantly improved schooling outcomes as a result of their fosterage status. Moreover, the siblings who were not fostered out also benefited, though to a lesser extent, most likely due to a reduction in the strain on household resources (Akresh 2005). Fosterage, therefore, may mitigate the effect of the dilution of resources by family size and be the reason for the weak associations found in early research. More recent research has found that urban families are increasingly unable to receive foster children (Courade 1994; Eloundou-Enyegue & Stokes 2002; Lloyd & Gage-Brandon 1994), which could increase the burden on individual families and strengthen the association between family size and schooling.

2.1.3 Endogenity and the dilution hypothesis

Beyond the need to contextualize the sib-size schooling relationship, one of the main critiques of the dilution hypothesis stems from the fact that it postulates a causal --rather than endogenous-- link between family size and children's resources. As Becker (1993) proposes, parents make a decision to invest in child quantity- via higher fertility levels- or quality- via fewer, more educated children (Becker 1993). According to this perspective, the negative association between sibsize and schooling is simply the result of prior, exogenous decisions and preferences of parents, which affect both fertility and schooling decisions.

If this is the case, then previous findings of a negative relationship between sibsize and schooling may be called into question. As Marteleto (2001) notes, "*if there is simultaneity between the decisions on number of siblings and desired educational attainment for those children, then neither additive nor interactive models of school attainment are correct as they assume that sibship size is determined prior to schooling*" (Marteleto 2001, p. 13). If an exogenous factor is determining both sibsize and schooling choices, then the findings of a negative relationship would overestimate the extent to which schooling would increase if family sizes were reduced (Marteleto 2001).

Yet, at the conceptual level, this assumption only holds if parents do indeed make rational, concurrent decisions about fertility and educational investments. As many scholars have proposed, there are conceptual reasons to assume that this may not be the case, especially in developing county contexts. First, with regards to the supply side of the relationship, this perspective assumes that individuals have strict control over their fertility, and bear the exact number of children intended. While this assumption may be suitable in developed nations, in developing countries *"couples control over reproduction is far from perfect, and, as consequence, the number of undesired reproductive events is substantial*" (Bongaarts 1997, p. 267). Estimates suggest that nearly 25% of births in developing countries (excluding China) are unwanted and, despite policies to promote family planning, levels of unwanted fertility have increased over time in many middle-income developing countries (Bongaarts 1994; Bankole & Westhoff 1995; Bongaarts 1995). Between the early 1970s/1980s and 1990, levels of unwanted fertility rose in many sub-Saharan countries, including Cameroon (.3 to .7), Ghana (.1 to 1.0), Kenya (.3 to 1.9), Nigeria (.1 to .3), Rwanda (.2 to 1.8) and Senegal (.2 to 1.0) (Bongaarts 1997). Despite three decades of increasing desires to cease or delay childbearing and the massive investments in family planning that have sought to meet this need, many women in developing countries continue to fall short of reaching their stated preferences (Westhoff & Bankole 1995).

In addition to the high levels of unwanted fertility, family size in the sub-Saharan context is also altered by the practice of fosterage. As noted above, fosterage rates remain high on the continent and the resource implications of fertility decisions are often spread among a larger extended family system. These high levels of unwanted fertility, combined with high levels of fosterage suggest that families are not exerting precise control over their family size and, thus, that at least portion of "sibsize" can be thought of as an exogenous factor.

A second problem relates to notion of a unified decision on the part of the *couple* about their reproductive decisions. Research has documented significant variation in couple preferences with regards to family size and has also highlighted "considerable power men wield" over women in reproductive decisions (Dodoo 1998, p. 229; Caldwell & Caldwell 1987; Ezeh, Seroussi & Raggers 1996; Wusu & Isiugo-Abanihe 2004) Using Demographic Health Survey data from 14 sub-Saharan African countries, Bankole and Singh (1998) find that "husbands tend to want a larger family than their wives," with gender differentials being larger in Western, rather than Eastern, Africa (p. 18). In Niger, more than 49% of husbands desire a family size of a least two children more than their wives (Bankole & Singh 1998). Similarly, in Ethiopia only 30% of husbands and wives gave the same response for ideal family size (Short & Kiros 2002). Among the majority of the sample of couples who did not agree on family size, husbands tended to be more pronatalist than their wives. More limited evidence suggests that these preferences actually impact family size. Using DHS data from the 1993 Ghana survey, Dodoo finds that contraceptive use was two to three higher when the husband, rather than the wife, wanted to cease child bearing (Dodoo 1998). Given the lack of consensus over family size, it's unlikely that concrete and unified decisions about "child quantity " are actually being made and, subsequently, achieved by many couples.

Beyond imperfect control over fertility, and the ambiguity surrounding the decision making process itself, many couples also have limited control over child survival. In sub-Saharan Africa, one of every six children dies before reaching age five (UNICEF 2006). Moreover, despite the United Nations Millennium Development Goal of reducing the under-five mortality rate by two-thirds by 2015, the region only reduced child mortality by 1% between 1990 and 2006 (UNICEF 2006). In developing countries overall, 72 of every 1000 children born die before the age of five, as opposed to 6 in developed nations (UNICEF 2008). Thus, a large number of families in these contexts experience an exogenous shock to family size via child mortality.

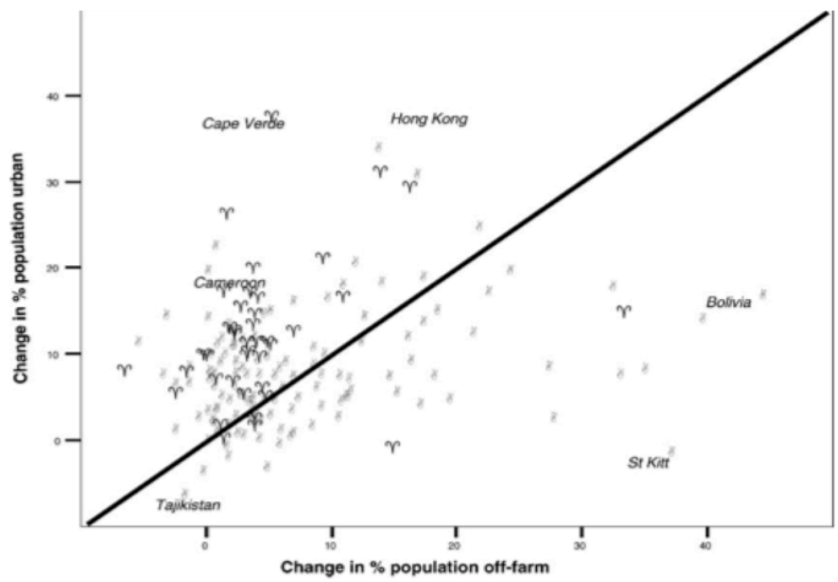
The "quality" side of the fertility-schooling calculus is fraught with problems as well. Not only do men and women have differential preferences with regards to family size, but evidence suggests that they differ in decisions about educational investments as well. In Ghana, Lloyd and Gage-Brandon (1994) find that teenagers in female-headed households are significantly more likely to have ever been enrolled in school. Using DHS data from Kenya, Tanzania, Cameroon, Niger, Malawi, Namibia, and Zambia, Lloyd and Blanc (1994) find that in all countries but Tanzania, despite being disadvantaged economically, children in female headed households are more likely to be enrolled in school and more likely to have completed grade school than children in male-headed households. Part of this can be attributed to the fact that female-headed households spend a greater proportion of the household budget on schooling than male headed households (Bruce & Lloyd 1996).

Parent's ability to make rational, simultaneous decisions about child quality and quantity is also dependent on a stable economic context. In many cases, time that elapses between decisions about fertility and decisions about schooling is large enough that changes in the broader socio-economic context may impact both the costs of, and returns to, schooling. First, considering the issue of costs, many countries in sub-Saharan Africa have substantial school fees associated with attendance. Yet recent constitutional and policy changes in several countries sub-Saharan countries have abolished these fees, significantly changing parental decisions about school enrollment. The elimination of school fees in Tanzania in 2001 caused primary enrollment to skyrocket, with the net primary enrollment rate growing from 57 to 85 percent within a single year (World Bank 2004). When Malawi abolished tuition fees in 1994, enrollment similarly jumped 51 percent, while a similar decision in Uganda in 1996 led to a 70 percent increase in enrollment (World Bank 2004). Even at relatively high national levels of enrollment, school fees continue to matter. The end of fees in Cameroon in 1999 resulted in primary gross enrollment rates growing from 88 to 105 percent (World Bank 2004). Thus, if a hypothetical family did make a deliberate decision to have many, low educated children in the contexts of high school fees, reductions in school costs may alter their calculus.

Second, broader socioeconomic forces that impact the returns to schooling may change drastically between the time of conception and the time when parents make decisions about schooling enrollment and/or dropout. Much of parent's impetus to invest in their children's schooling is based on the idea that this investment will improve socioeconomic opportunities and trajectories. However, contextual changes that occur between these two processes may alter parent's decisions about schooling. Even researchers like Montgomery, Kouame and Oliver (1995), who are highly skeptical regarding a causal relationship between sibsize and schooling, have conceded this point. As they note *"fertility can exert a causal influence on child schooling in the short run, however, especially under conditions of rapid and unanticipated change in economic circumstances such as those characteristic of the past decade in West Africa. In those settings, the number of children born by a household may not correspond to the number that would have been chosen given knowledge of current economic circumstances*" (p.11).

Consider a hypothetical scenario where a family makes a calculated decision to have a few, well-educated children, and are then faced with changes in the broader socio-economic context that reduce the returns to schooling. In this case, parents may simply pull back on schooling investments and choose to have a few children with low levels of schooling. This hypothetical scenario is quite probable in much of sub-Saharan Africa, where evidence shows that changes in the socioeconomic conditions are severely reducing the returns to schooling. Overall, unemployment among 15-24 year olds in the region hovers around 50% (Zuehlke 2009). In Nigeria, the rate is closer to 60-70%, with "the labor market only absorbing 10 percent of new job entrants" (World Bank 2009, p.1). The Minister of Finance in Mali recently lamented that "youth in urban areas are looking for jobs alongside thousands of others from the same schools" which is largely a result of "policies [that] favor investments and educational training" but do not lead to job creation (World Bank 2009, p.1). Despite annual economic growth rates averaging 6 percent per year between 1997 and 2007, there has not been a commensurate increase in employment opportunities among young workers (ages 15-24) (Zuehlke 2009). While labor productivity has been growing SSA, the employment to population ratio has stagnated between 1991 and 2007 (UNDP 2010). Declines in this ratio were registered in 28 of 50 SSA countries, with the largest declines in Mauritania (13.8%), Tanzania (10.6%), and Rwanda (8.1%) (UNDP 2010). Southern Africa was able to improve their ratio during this time period, but East and Central Africa remained stagnant and West Africa regressed. Previous research by Giroux (2008) also suggested asymmetric growth with regards to employment and population. Figure 2.2 displays the percent change in off-farm employment (X axis) and in urban population (Y axis) over the last two decades.

Figure 2.2 Stage and symmetry in urban transitions (Giroux 2008)



Countries that fall on the diagonal line have experienced equal growth in both their urban populations and levels of off farm employment. However, countries that fall to the right of the diagonal have experienced faster growth in off-farm employment than in urban population, while the reverse is true for countries to the left of the diagonal. As this graph indicates, most sub-Saharan countries (indicated by the v shaped mark) fall to the left, underscoring an asymmetry noted in other studies (Kasarda & and Crenshaw 1991; Roberts 1989; UN 2004). Given this increasingly competitive labor market, parents may be more and more discouraged from investing in schooling, regardless of previous fertility decisions.

In sum, concerns regarding the overestimation of sibsize on schooling are more valid in contexts where parents make a calculated decision about fertility and schooling, and are then able to achieve these desired goals. In sub-Saharan Africa, high levels of unwanted fertility and mortality and a lack of matched fertility preferences within the couple suggest that couples are not likely to be able to perfectly achieve their ideal family size. Similarly, there may be little consensus within the couple as to the ideal educational attainment of children. In addition, parents are faced with changes in the costs of, and returns to, schooling that can impact schooling decisions regardless of family size. The contextual factors at play in the region decrease the likelihood that analysis of the impact of sib-size on schooling will be overestimated.

Perhaps some empirical evidence suggesting a lack of support for a quality-quantity tradeoff is the result of these contextual factors. If parents make a calculated decision at one point in time to invest in both child quantity and quality, one would expect a strong negative association between parent's educational *preferences* and sibsize (Knodel & Wongsith 1991). However, in Thailand, Knodel and Wongsith (1991) find that parent's educational preferences for secondary schooling has a weak and inconsistent relationship with their actual number of children.

Gomes (1984) similarly finds that African parents do not make a clear tradeoff between few, educated children or many children with little schooling. Instead they "can have many children and educate a high proportion of them as long as they … [can] induce the advantaged children to finance the education of their younger siblings (Gomes 1984, p. 648). More broadly in some African societies, there is a normative expectation that it "takes a village" and that individual parents are typically not expected to bear the full burden of raising their children. Rather, assistance is expected from relatives and from older siblings in a mechanism that has been labeled "siblings chain of assistance" (Shapiro & Tambashe 2001). With these norms, parents' socialization of first-borns emphasizes loyalty to parents and responsibility to the younger siblings, and parents invest strategically in social networks. For instance, in Southern Cameroon, such strategic investments are seen in processes of naming or christening children, as families typically name their children after—or select godparents from – relatives who appear more likely to assist in the childrearing effort.

2.1.4 Dilution in Summary

Resource dilution (Blake 1981; 1989; Downey 1995) offers a classic argument for expecting a human capital dividend from transitions. In its simplest formulation, large families reduce the average resource available per child, because parental resources must be divided among multiple siblings. However, further empirical work, especially in developing settings, necessitated the consideration of important contextual factors (i.e. stage in development, stage in fertility transition, national schooling context) and the acknowledgment of certain problematic assumptions (i.e. a bounded nuclear family unit with fixed resources). Additionally, the potential for endogeneity problems has led many researchers to fully consider the context shaping fertility and schooling decisions[3], as well as develop methodological tools to better estimate the effect of sibsize on schooling. All in all, however, *"most scholars have discounted the claim that the link between sibship size and all forms of educational outcomes are completely artifactual ...The question is not whether there is some spuriousness, but rather how much of the effect is spurious*" (Steelman et al. 2002, p. 254).

2.2 From Micro-level Dilution to Macro Level Implications.

The dilution hypothesis is a powerful tool in understanding how changes in family size impact resource allocation and schooling outcomes. However, its biggest limitation is that it theorizes at the micro, family level, while policy interest in the sibsize-schooling relationship tends to be focused on the macro, societal level. For policymakers, the central question is how national transitions in total fertility rates impact national schooling levels, not how family decisions about sibsize impact individual children's schooling outcomes.

While this disjuncture stems largely from social scientist's greater confidence in micro-level analysis[4], it is problematic on a variety of fronts (NRC 1986; Cassen 1994).

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[3] Obviously, a theoretical argument alone is likely not enough to allay concerns about endogeneity problems. In order to truly capture cases of exogenous fertility and examine its effect on children's outcomes, researchers have also used methodological approaches, namely instrumental variables (natural policy experiments [e.g. sudden changes in birth control or abortion laws], random placement of family planning clinics, twin births, gender of first-borns, or reportedly unwanted fertility). These approaches, and other relevant methodological issues, are discussed in Chapter 3.

[4] Much of the shift towards research grounded in micro level data is due to concerns raised over macro level analysis, specifically, methodological problems associated with cross-country regressions (see the methods section). However, some of the shift may also be attributed to the ideological retreat from using national level measures when concerned about issues of fertility (a micro level decision) that emerged during the 1994 International

Although it has been recognized that these levels of analysis are not mutually exclusive-nations consist of families and households, and national policies affect the decisions made at the household level- the problems associated with using micro data to create a macro-level picture have not always been fully articulated or addressed.

First, the bulk of studies on the sibsize-schooling relationship use cross-sectional evidence. While, in and of itself, this might not be an issue, using cross sectional data to infer historical change does raise concerns over the practice of "reading history sideways," an issue Arland Thornton brought to the forefront in his 2001 presidential address to the Population Association of America. The central point that Thornton challenges is the notion societies evolve through a series of uniform and progressive stages from "traditional" to "modern" and that this transition is both desirable and inevitable. With respect to the fertility-schooling relationship, one can imagine the problems that might emerge by using cross sectional data from different countries to develop a coherent narrative of the relationship between stage in the demographic transitions and schooling enrollments. If country X has a total fertility rate of 5 and a primary school enrollment rate of 70 percent and country Y has a total fertility rate of 4 and a primary school enrollment rate of 80 percent, that does not mean that we can firmly expect a 10 percentage point gain in schooling enrollments in country X if their TFR declines from 5 to 4. Instead, the best way to understand the trajectory of this relationship is to consider the relationship over time, within a single country.

Reverse ecological fallacy, which occurs when micro-level findings are used to infer aggregate relationships, is a second problem that emerges when using sibsize-schooling findings to inform our understanding of the impact of fertility transitions on national enrolments (Bernard 2000). In this case, this fallacy rests on problematic assumptions regarding 1) the evenness of fertility transitions and 2) the stability of dilution effects.

Conference on Population and Development in Cairo (Cassen 1994; Finkle 1994). At the conference, a new model was proposed that shifted emphasis from the broader society to the individual, with a focus on women. The core idea that emerged from the conference was that population programs should not emerge from a generic concern over society (development) but from the individual needs of women (welfare). This, therefore, encouraged a shift from a macro to micro perspective.

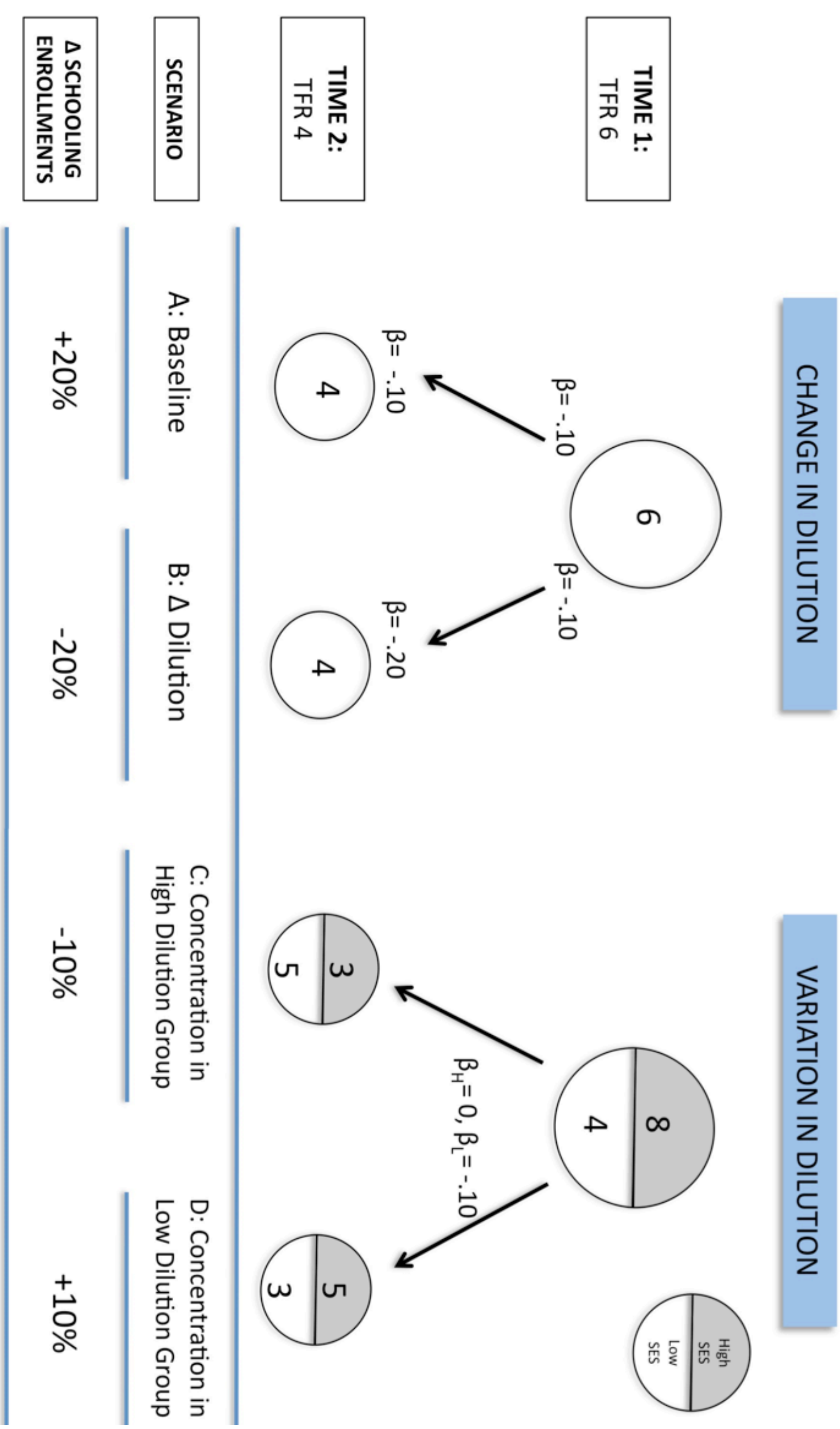
With regards to evenness, if the effect of sib-size on schooling is non-linear, then the aggregate impact will depend on whether of not national fertility declines occur evenly among all families (NRC 1986). Thus, to infer the national-level effect of fertility declines, one needs information about the distribution of fertility change and the schooling differentials associated with various sibsize. Despite this fact, only a limited number of studies have attempted to address this issue. Working in Thailand, Knodel and colleagues (1990) address this problem by conceptualizing fertility transitions as changes in the proportion of children experiencing various sibsizes, then applying the corresponding schooling differentials.

With regards to the stability of the dilution effect, although most previous evidence on the sibsize-schooling relationship suggests that the dilution effect increases as countries progress through their stages in the demographic transitions, this fact has not been accounted for empirically (Lloyd 1994). While Knodel et al.'s developments helped to explain how micro-level dilution translates into a national-level dividend, they also recognized the second problematic assumption, notably "the effects of family size on children's education may well change during the course of fertility transition" (Knodel et al 1990, p. 52). The problem with not fully accounting for evenness and stability is illustrated in Figure 2.3 (Eloundou-Enyegue & Giroux, forthcoming).

Figure 2.3 highlights the problems with using micro-level estimates of sibsize effects to infer macro-level transition outcomes. The first scenario (A) on the left-most side illustrates a country with an average sibsize, or dilution, effect (β) of -5 at the onset of its fertility transition, i.e., each additional sibling reduces the probability of school enrollment by 5 percentage points. Thus, if total fertility rates decline from 6 to 4, the country could expect a 10 point gain in enrollments. While this rationale seems sensible, it proposes three problematic assumptions: 1) that the average sibsize effect (β) remains constant over time and 2) that the dilution effect is the same across all sub groups and 3) that fertility declines evenly among all subgroups.

Previous research clearly shows that each of these assumptions are questionable. Sibsize effects (β) may change over time, including during fertility transitions (Lloyd 1994, Lu & Treiman 2005, Maralani 2008); sibsize effects might be curvilinear, or they can vary across key sub-populations defined by sex, ethnicity rural residence, or income (Anh et al. 1998; King 1987); and fertility may decline unevenly (Bongaarts 2003; Giroux, Eloundou-

Figure 2.3 Illustration of changing dilution and composition effects during the fertility transition (Eloundou-Enyegue & Giroux forthcoming)



Enyegue & Lichter 2009; Kirk & Pillet 1998; Shapiro & Tambashe 2002). Scenario's B, C and D in Figure 2.3 show how failure to consider these factors can result in inaccurate conclusions about the macro impact of fertility transitions

In the case of Scenario B, the dilution effect (β) increases from -5 to -10 as the country progresses through the demographic transition. Even through the fertility decline is the same as in Scenario A, the predicted outcome is a 10 point decline in schooling. One way to calculate these transition-related gains is to consider, for each time period, the group's reduction in enrollment probabilities, relative to a baseline situation of no siblings. In scenario A (time 1) for instance, this reduction is 6 siblings multiplied by a dilution factor of (-5), i.e. -30. At time 2, the reduction is 4 siblings multiplied by a dilution factor of (-5), i.e. -20. The change associated with the transition is thus (-30)-(-20), or a 10 point gain. In scenario B, the reductions are -30 (6 siblings* (-5)) at time 1, and -40 (4 siblings*(-10)) at time 2, for transition-related decline of 10 points in school participation.

Scenario C and D demonstrate the importance of following Knodel et al.'s lead and considering variation in dilution (β) and transition (ΔF) among different subgroups. Whereas scenario A posited a homogenous population with an even decline in fertility and an even sibsize effect (ΔF =-2 and β =-5 in both subpopulations), scenarios C and D assume no sibsize effect (β = 0) in one subpopulation and a very strong effect (-10 point) in the other. Furthermore, the fertility decline in scenario C is relatively even, while it is highly uneven under scenario D. The predicted outcomes under these new conditions become +15 and +25 respectively. The same logic applies for the calculation of the education gains as in the case of Scenarios A and B, except population weights are now applied. Thus, in scenario C the reduction at time 1 is (0.5*8*-10)+(0.5*4*0)= -40. At time 2, it becomes (0.5*5*-10)+(0.5*3*0)=-25. The change between the two times is thus -25-(-40).

In sum, scenarios A through D yield very different 'transition effects,' even as they assume the same fertility decline and initial sibsize effect. Clearly, information about the magnitude of both the initial sibsize effect (typically what is generated from a micro-level analysis) and the fertility decline is insufficient to infer the aggregate 'fertility transition effect.' In order to effectively harness the statistical power of micro level data, researchers need an empirical approach that can harness the statistical strength of micro-level estimates. The extent to which this can be achieved using a decomposition method is discussed a length in the methods section.

2.3 Dividends from transitions

So far, we have considered 1) micro-level studies that focus on the relationship between sibsize and schooling and 2) micro-macro approaches that aggregate micro-level information to infer national level relationships between fertility transitions and schooling outcomes. However, a third way to examine the relationship between fertility trends and schooling is to consider the relationship between age structure, an entirely macro level variable, and national schooling outcomes.

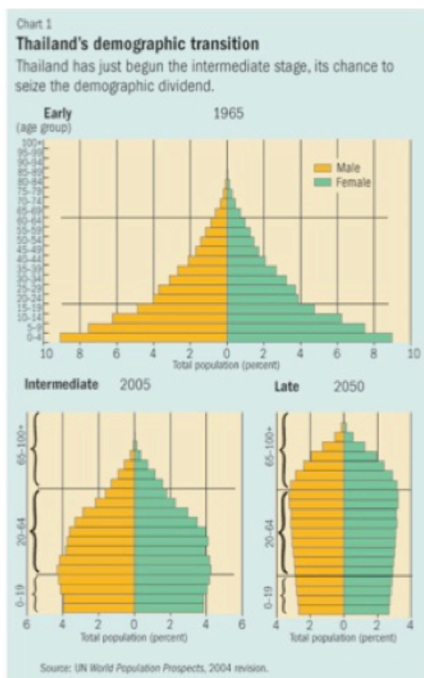
2.3.1 Conditions for the dividend

Fertility decline not only impacts the number of children present in a society, but also shapes the age structure of that society. Whether or not a society is older or younger has implications for overall development. Globally, vast differentiation in the average age of societies has emerged over the past 50 years. In 1950, the difference in median age between the world's oldest (Japan) and youngest (Yemen) counties was 2.7 years (Hewitt 2004). By 2004, this figure had risen to 24 years and is expected to be 35 years by 2025 (Hewitt 2004). Crenshaw et al. (1997) found that a growing child population, as occurs with declining mortality in a high fertility context, reduces economic development in developing counties. A younger population means a larger number of dependents, who require resources that might otherwise be invested in broader economic development activities.

However, as fertility begins to decline, societies experience a "*demographic windfall effect whereby that demographic transition allows a massive, one-time boost in economic development as rapid labor force growth occurs in the absence of burgeoning youth dependency*" (Crenshaw et al. 1997: 974). This phenomenon, typically referred to as the demographic dividend, posits that as fertility declines, the age structure of the population shifts to improve dependency ratios. However, the window of time that counties have to capitalize upon the dividend is relatively short, as the dependency ratio begins to worsen over time as older workers retire and the proportion of elderly dependents expands (Ross 2004; Bloom, Canning, & Sevilla 2003).

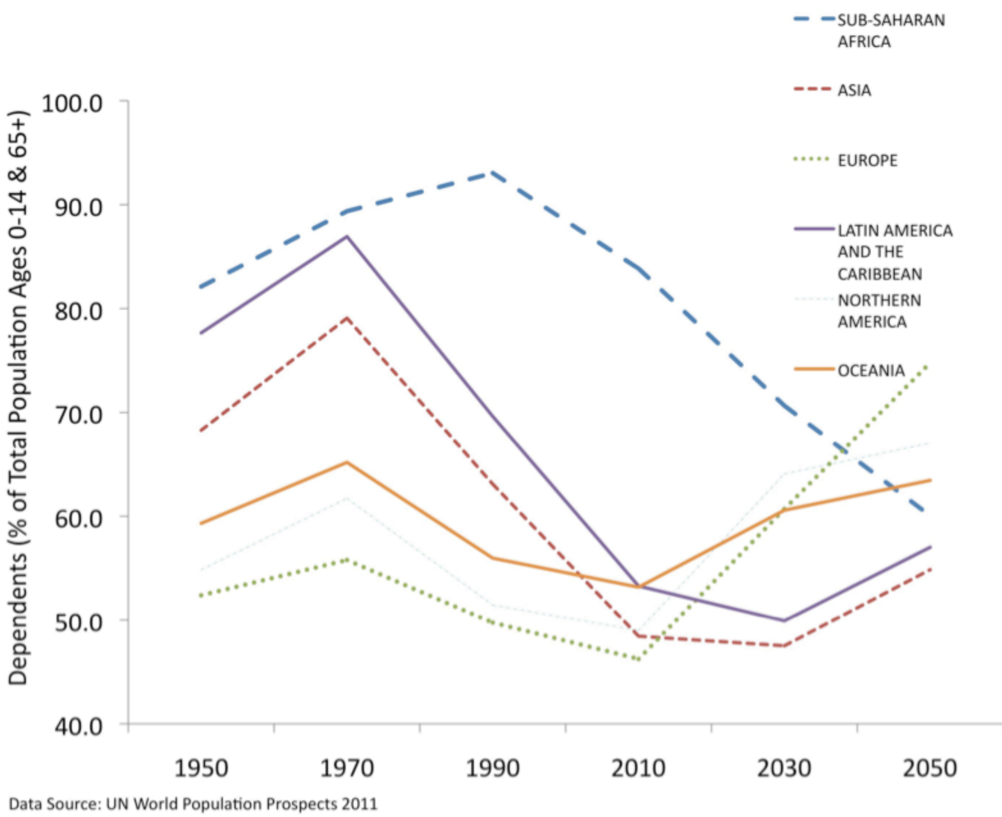
Figure 2.4 (UN 2004) illustrates Thailand's progression through the demographic transition. In the early stage (1965), the proportion of the population in ages 0-19 vastly outnumbers the working age population ages 20-64. As fertility declines, a "window of opportunity" opens (2005), and the population aged 20-64 outnumbers the young dependent population. It's during this time that countries have the opportunity to realize the demographic dividend. By 2050, the chance to capitalize on this dividend has ended, as the proportion of old and young dependents outnumbers those in the working age group.

Figure 2.4 The Emergence of a Demographic Dividend, Thailand 1965-2050 (UN 2004).



The potential of the demographic dividend is particularly relevant in sub-Saharan Africa. As seen in Figure 2.5, nearly most world regions have moved through the demographic transitions, and North America, Ocean, and Europe have passed the window of opportunity for the dividend. Conversely, the decline in the dependent population only began in sub-Saharan Africa around 2000.

Figure 2.5 Trends in the Dependent Age Populations in Six Regions, 1960-2040 (UN 2011).



In SSA, conversely, the proportion of the population comprised of working age adults is growing, and thus the region is entering its window of opportunity. If fertility continues to decline[5], and if governments can enact policies that capture the potential of the dividend, then shifting age structure may present a real opportunity to achieve social and economic development in Africa.

[5] Historic fertility declines have been well documented in the region. However, the more recent evidence also indicates cases of fertility reversals and stalls (Bongaarts 2006; Bongaarts 2008; Shapiro & Gebreselassie 2008).

2.3.2 Types of dividends

The bulk of research on the demographic dividend has focused on how changes in age structure generate macroeconomic dividends in terms of savings, economic growth, and poverty reduction (Birdsall, Kelley, & Sinding 2001; Bloom, Canning, & Sevilla 2002; Greene & Merrick 2005; Mason & Lee 2004). For example, research in East Asia suggests that about 30 percent of the regions' increase in per capita income was due to changing age structure (Bloom and Williamson 1998). Similarly, Mason (2001) found that the dividend accounted for nearly 25% of the region's economic growth. Much of the economic success of the "Asian Tigers" has been attributed to the government's ability to capitalize on the demographic bonus (Mason & Lee 2004). Similarly, in Brazil research found evidence for a 0.7% annual growth in GDP as a result of declining fertility (Mason & Lee 2004).

Yet, there is no need to exclusively focus on economic dividends. A more favorable age structure should also generate a human capital dividend, specifically by improving the schooling and health of national populations (Anh et al. 1998; Bhat 2002; Knodel et al 1990). As birth rates fell in the Republic of Korea during the mid-1960s, the total number of children enrolled in primary school fell as well. Because smaller primary enrollments required fewer resources, the government was able to divert more funds to improve the quality of higher education (Ross 2004). However, without good governance and policies that encourage productive investment, the dividend can be easily squandered. In Costa Rica, the 1980s were characterized by the highest rates of growth in the school age population, as well as a massive financial crisis (Robles 2005), As a result of this crisis, funding to education declined in both real and percentage terms. As a result, the 5 to 17 year old cohort during the 1980s experienced secondary enrollment ratios lower than those of earlier cohorts. By the time this cohort reached the labor force their lower levels of human capital had significantly reduced the quality of the workforce and played a role in the subsequent economic stagnation (Robles 2005).

Future fertility declines in sub-Saharan Africa are setting the stage for a context where governments might expect vast improvements in overall levels of development- via growth and improvements in savings, education and health. With 44 percent of its population under age 15 in 2006, sub-Saharan Africa is the youngest region of the world and only 11 counties are projected to reach their maximum working age population before 2050 (Ashford 2007; UN 2004). Policy makers can improve the likelihood of capturing this windfall via targeted policy interventions. First, they must ensure continued fertility decline. Recent evidence suggests that the future of fertility transitions in SSA remains uncertain. Despite dropping from 6.72 in the 1970s, fertility in the region continues to be high at 4.76 in 2010. Moreover, research by many scholars (Bongaarts 2006; Bongaarts 2008; Shapiro & Gebreselassie 2008) has documented stalls and reversals in the region's fertility decline. Using DHS data from 19 sub-Saharan countries, Bongaarts (2006) finds that two countries (Ghana and Kenya) show evidence of a fertility stall, twelve show a declining trend in fertility, and five are still in the early stages of their transitions. Shapiro and Gebreselassie followed up on these findings in a 2008 paper that examined 24 SSA countries and find that the fertility transition has begun in nearly all countries, and in 65 percent of the cases show a persistent fertility decline. However, the rate of fertility decline is low in many of these cases, and in 35 percent of cases stalls (in both early and mid-transitions) were evident. These stalls follow Lesthaeghe's (1989) prediction over 20 years ago that fertility decline in sub-Saharan Africa might stall at high levels (4-5 children), given the importance of children in the production of old-age support.

Thus, a full realization of the dividend will depend both on policy makers ability to improve socioeconomic conditions broadly, but also the availability of comprehensive family planning programs, as Bongaarts (2006) found that in countries where fertility decline has recently stalled "levels of unmet need and unwanted births are relatively high, and improvements in access to family planning methods would, therefore, be desirable" (p. 1). As of 2004, all countries in sub-Saharan Africa had integrated a minimum package of reproductive health services into primary health care, and the increased availability of these services has likely played a role in the 50 percent growth in the use of contraceptives between 1990 and 2000 (UNICEF 2001). During this period, contraceptive use more than doubled in seven Sub-Saharan counties, including Burkina Faso, Guinea, Niger, and Uganda- where contraceptive use had been less than 10 percent at the start of the decade (UNICEF 2001). Yet despite these gains, the overall rate of prevalence in the region is strikingly low. Only 28% of women use any method, and only 21% use a modern method (UN 2009). In order to fully capitalize on the dividend, countries must ensure that women are able to actualize their desires for smaller families.

Beyond future fertility declines, the realization of the dividend in SSA will also depend on whether or not countries have a productive workforce at the time when their largest cohorts enter the labor force. Thus, governments need to invest heavily in schooling, which, as noted above, continues to be a challenge. Schooling must also be viewed as an attractive investment for individuals and families. Given high levels of unemployment and underemployment in many counties (Giroux 2008), there may be a declining incentive to invest in education. If African governments miss the boat on the demographic dividend, things could actually worsen as dependency ratios at older ages grow and the problems associated with an increasingly older population emerge. Timely intervention is critical, as *"a failure to act on these issues could have a damaging effect on future prospects, as unemployment rises, the social fabric crumbles, and rising numbers of old people begin to overwhelm available resources. ...Embracing and understanding demographic challenges must therefore be a priority for all governments..."* (Bloom, Caning and Sevilla 2003, p. 74).

2.3.3 Dilution versus dividend

Conceptually, the dilution argument focuses on the impact of declining sibsize on family level decisions about schooling investments. The dividend argument proposes a related scenario at the macro-level. As the ratio of dependents to workers shrinks, national resources previously directed towards supporting the large child population can be diverted towards other productive social and economic activities. However, the dividend argument differs from the dilution argument in a few critical ways.

First, the intervening mechanism in the dilution argument depends on decision-making that occurs at the individual level, while the intervening mechanism in the dividend argument is a macro-level process, whereby individuals can reap dividends regardless of their own fertility behavior. This macro-process depends on trends in relative cohort size, rather than sibsize as is the case with dilution, and the two trends aren't always simultaneous (Lam & Marteleto, 2005). Also, the dividend addresses supply factors and the corresponding public resources, while dilution is about demand factors and private resources. Last, the two differ in terms of the issue of timing. While individual families can benefit from smaller family sizes at nearly any time, the dividend can only be realized by a society during a small "window of opportunity". This "window" is relatively short- eventually the large cohort of workers will age into older dependents, and are likely to drain resources from the then comparatively smaller working age population.

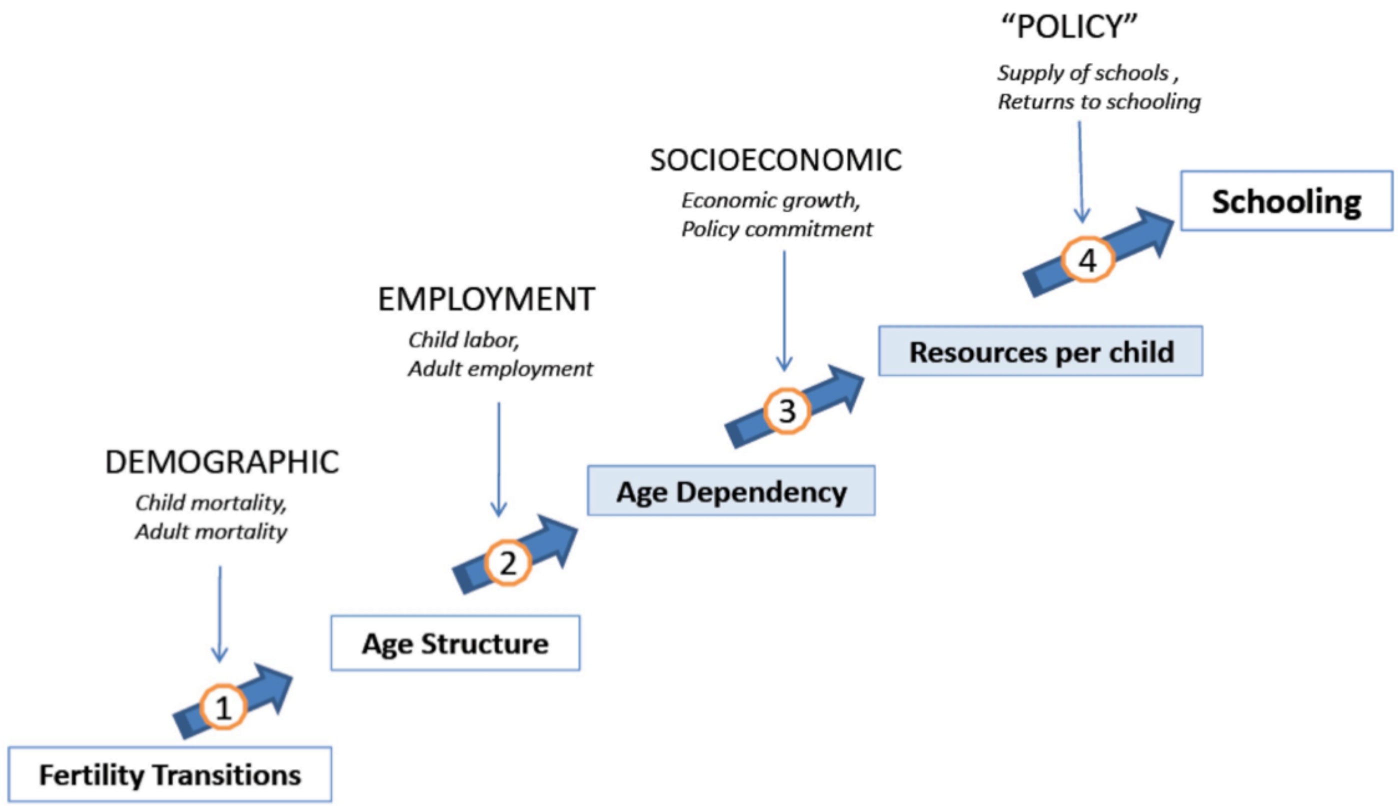
2.3.4 Production of the dividend

The dividend does not automatically emerge with a changing age structure. Bloom, Canning, and Sevilla (2003) identify three specific mechanisms through which the demographic dividend is converted into an economic dividend: (1) changes in the labor supply; (2) changes in savings patterns; and (3) changes in levels of human capital. With regards to labor supply, the dividend occurs as the large number of children born during periods of high fertility move into the labor force as effective workers, ideally with strong educational and vocational training (Bloom, Canning, and Sevilla 2003). Additionally, larger numbers of women, freed from caring for large families, are also able enter the workforce. In order for this to occur, strong government policies that create more jobs are critical- otherwise countries will simply experience a bulge of unemployed workers.

As working age adults tend to earn and save more, the growing working age population then favors greater personal and national savings (Bloom, Canning and Sevilla 2003). The greatest period of savings occurs when the bulk of workers enter their 40s, as their dependents are typically establishing their own households and require fewer resources. As these personal savings grow, they can be invested in productive ventures that encourage broader economic development. Lastly, the demographic dividend is realized through improvements levels of human capital. Having fewer children not only allows women to enter the workforce, but it also improves their health, social status, and personal independence (Bloom, Canning and Sevilla 2003). Smaller families also tend to free limited household resources to provide better food, health and schooling for children, especially for girls.

The schooling dividend is similarly not a guaranteed outcome from fertility decline. Instead the process must unfold through a series of sequential steps. Figure 2.6 (Eloundou-

Figure 2.6 Conceptual Framework for the Dilution Argument (Eloundou-Enyegue & Giroux forthcoming *b*)



Enyegue and Giroux forthcoming *b*) outlines the precise nature of the dividend-production process with regards to schooling outcomes.

First, declines in fertility alter age dependency. Then, age dependency reduces real dependency, and the distinction between the two concepts is outlined below. The third step links real age dependency to resources. As dependency is lowered, the resources available per capita increase, but this boost also depends on trends in national resources and budget allocation. Finally, in step 4, resources are converted into schooling outcomes, a conversion that depends on a country's policy effectiveness in transforming resources into schooling outcomes.

The process outlined in Figure 2.6 raises two important points. First is the difference between age and real dependency. Although the two concepts seem synonymous, the first is purely demographic while the second has more socioeconomic meaning. Age dependency is the proportion of children 0-14 relative to working-age individuals (15-64). In real terms however, dependency is the ratio of dependent children to working adults. Dependent children are only a subset of all children, especially if child labor and child-headed households are common. Working adults are likewise a subset of the total population in the working ages. In addition to age structure, real dependency thus depends on norms about working ages and current employment, meaning that jobless growth for instance need not ease real dependency. The first point, then, is simply that age and real dependency ratios can be quite different.

A second remark is with regards to the time lag between changes in fertility and changes in age structure. A 15-year lag is expected before birth cohorts can work their way through the age structure and fully alter the child dependent population. Thus if one wanted to study changes in age structure between 1990 and 2005, the relevant period for changes in fertility is 1975-1990.

The detail in Figure 2.6 offers three insights. The first is to reveal the contextual forces affecting each step in the process. Such forces include the levels of child and adult mortality (first step), the trends in child labor and adult unemployment (second step), the economic performance and public commitment to children (third step), and policy (fourth step). In sum, policy (narrowly understood here as the extent to which national governments transform resources into outcomes) is not the only obstacle to the dividend. Dividends also depend on normative and economic context as well as on the characteristics of fertility transitions, even though these other forces are often downplayed in earlier, black-box presentations of the dividend argument.

As a second insight, a detailed presentation clarifies why previous studies might have emphasized good policy as key component in realizing the dividend. Conceptually, the four steps in Figure 2.6 represent two distinct sub-processes. The first sub-process (steps 1 through 3) relates to the production of a resource opportunity. Its end product is a "bonus" i.e., a resource opportunity, in the form of more public spending per child. The second sub-process (step 4) is about the transformation of opportunity into outcome, with the end product being the schooling "dividend," i.e., final outcomes such as enrollments or attainment. By equating "bonus" and "dividend," analyses will likely emphasize the last step (the transformation of the resource opportunity) and therefore miss the earlier steps. Missing these earlier steps logically implies missing contextual influences other than policy. Clearly, the transformation of the resource opportunity depends on policy, specifically policies affecting the efficient transformation of public resources into favorable schooling outcomes (Binder, 2009). However, the first sub-process (creating the resource bonus) depends on other factors that merit attention.

Regardless of whether we conceptualize the dividend as a social or economic outcome, causal issues plague this research as well. First, the mortality and fertility declines accompanying a demographic transition are not only catalysts of rapid economic growth, but are also outcomes of factors associated with economic growth (Birdsall, Kelly & Singding 2001). Indeed fertility decline may promote socioeconomic development, but factors like increases in educational attainment and expansion of the labor market are likely to drive down fertility as well. Thus, if the issue of reverse causality is not taken into account, the estimates of the effect of age structure on economic development might be exaggerated. Yet at the same time, given the fact that the fertility-development link may be a mutually reinforcing process with larger cumulative effects means that an initially small decline in fertility may lead, in the long term, to substantial growth. Thus, the estimates may also be minimized. Bloom and Canning (2001) suggest the possibility of such a reinforcing effect of the two-way causal relationship between fertility and economic growth. Overall, regardless of the precise nature of the estimates, it is now more widely agreed that given the right policy conditions, an improving age structure sets the stage for the realization of a demographic dividend (Birdsall, Kelly & Singding 2001).

2.4 Fertility transitions and schooling

2.4.1 Relevance of Schooling

Interest in the potential dividends associated with fertility transitions is perhaps unsurprising given the well-documented concerns within the global development community over the expansion of education. Education, especially at the primary level, has been cited as a critical factor in encouraging broader socioeconomic development in an array of studies, especially in sub-Saharan Africa. At the micro level, Gomes (1984) finds evidence in Kenya that parents who invest in their children's schooling can expect "direct income returns" (p. 647). In Kenya, completion of primary school is associated with higher incomes, lower levels of infant and child mortality, and reductions in gender inequality (Lloyd et al. 2000).

Education plays an especially important role for women. Educated women tend to have smaller families as they are more likely to marry later and use modern methods of contraception (Diamond et al. 1999; Jejeebhoy 1995; Muhuri et al. 1994). Education also makes women "better able to appreciate and interpret media messages, deal with bureaucracies, enter the labor market, and have better dialogue with their spouses than their less educated counterparts" (Diamond et al. 1999, p. 31). Not only does mass education results in "the direct influence of education on individuals" but it also encourages "interaction among knowledge, ideas, and increased opportunities afforded by mass education through the restructuring of family and community relationships" (Diamond et al. 1999, p. 31). In counties with mass education systems, women with a few years of education are more likely to adopt norms of lower fertility and delayed marriage, even though the actual impact of years of schooling on their fertility decisions may be very small (Diamond et al. 1999).

At the national level, Barro (1991) examines 98 countries between 1960 and 1985 and finds that the growth rate of GDP is positively related to school enrollment rates.

Higher levels of human capital are also associated with lower fertility rates and a higher proportion of the GDP in physical investments (Barro 1991). Not only does growth in primary enrollment boost socioeconomic development, it appears to generate higher returns than investments made at other levels of education. In a review of 98 country studies from 1960-1997, Psacharopoulos and Patrinos (2004) found significantly larger rater of return on investments in primary schooling over investments made at the secondary and tertiary levels.

Given the importance of education, it was included by the U.N. on a list of the top eight global development priorities. Goal Two of the Millenium Development Goals seeks to: "Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling" (UN 2010). While it is widely agreed that the Millennium Development Goal of universal primary education may not be reached by 2015, between 2000 and 2007 efforts to improve primary enrolments led to a 42% enrolment gain in sub Saharan Africa (Fleshman 2010). Nevertheless, the total primary school net enrollment rate for all children only reached 58% in 2000, falling far behind the global average of 84% (EFA 2000). Similarly, the secondary school gross enrollment rate is a globally low 26% (EFA 2000) More recently, education reversals, resulting from the economic crises of the 1980s and 1990s, have been noted in many African countries, with young adults being less educated than their forbearers (DeRose & Kravdal 2007, Eloundou-Enyegue & DaVanzo 2003, Lloyd et al. 2000).

The severe lag in enrollments themselves provides a definitive rationale for considering the relationship between fertility and schooling enrollments. However, beyond this well-deserved concern over meeting the enrollment goals, there has also been recognition that gains in enrollments should not be the only focus. Indeed, although the official MDG target is measured by the number of children enrolled in primary schooling, the full vision embraces *quality* and *equity* (UN 2010).

2.4.2 Beyond enrollments

As policies are pursued to achieve greater enrollments, there is concern that educational quality could be stagnating or even declining. As a recent UN report concluded, "*some of the successes in raising enrollments have come from policy decisions to eliminate* *school fees but the surge in enrollment after abolition of fees brought huge challenges in providing sufficient school buildings and teachers*" (UN 2008b: p.1). In 2003, Kenyan teachers and administrators at schools had to scramble for desks, textbooks, and classroom space for the million extra students that entered schools after the government announcement of the abolishing of school fees (Fleshman 2010). Over the past 15 years, numerous other African countries- including Burundi, the Democratic Republic of the Congo, Ghana, Ethiopia, Malawi and Mozambique have experienced similar large surges in enrollment associated with the elimination of school fees (Fleshman 2010). While countries like Kenya have been relatively successful in balancing growing enrollments with quality- keeping its national student to teacher ratio below 40 to 1 and procuring one textbook for every three students in most subjects – other countries have been less successful at maintaining high quality schooling (Fleshman 2010). Malawi ended school fees in 1994, but with a lower GDP per capita and little financial support from outside actors, educational spending per student declined by 25 percent and instructional quality weakened. Not only did the student to teacher ratio increase to 70 to 1, but the bulk of new teachers hired were secondary school graduates given two weeks of teacher training (Fleshman 2010). This quality decline in turn encouraged high dropout rates (Fleshman 2010).

Given the policy interest and substantive importance of schooling quality, it is somewhat surprising that few studies in the sibsize-schooling literature focus on issues of quality. Arguably, enrollments do matter- whether children are in school is an a priori condition that must be met before one raises concerns over schooling quality. Moreover, the simple act of enrollment and attendance has intrinsic value beyond the instrumental benefits of instruction: schools facilitate processes of socialization and may offer a protective environment, shielding students from violence, predation, child labor, and risk-taking behavior.

Beyond the conceptual and policy reasons to focus on enrollment and/or attainment status, enrolment status or attainment level are often the only schooling related data available to investigate the sibsize-schooling relationship in much of the developing world. In the case of sub-Saharan Africa, the Demographic Health Surveys and the World Bank have fairly robust annual data on primary enrollments, but are severely lacking information on tuition, libraries, class size, teacher qualifications, textbooks or other typical indicators of school quality (Darling-Hammond and Bransford, 2005; Glenwwe, Kremer and Moulin, 2008; Goldstein, Yang, Omar, Turner, & Thompson, 2000). Some studies have measured quality by learning and performance on standardized testing, but as few African countries have consistently participated in international testing, cross-country and historical analyses based on testing scores are difficult.

Thus, despite the policy interest in both schooling enrollments and quality, the vast majority of research on the dilution and dividend hypotheses has focused exclusively on enrollment or attainment, versus quality, as the educational outcome. One could easily pose a variety of interesting questions about the sibsize-schooling relationship at both the micro and macro levels. For example, at the micro level, how does sibsize impact the quality (as indicated by academic performance, tuition or extracurricular schooling factors such as tutors or access to computers in the household) of schooling a child receives? A handful of studies have attempted to address this issue (Darling-Hammond and Bransford, 2005; Glenwwe, Kremer and Moulin, 2008; Goldstein, Yang, Omar, Turner, & Thompson, 2000) but few have focused on sub-Saharan Africa, and those that have are often limited in geographic scope. A review the literature shows no evidence of research that examines the macro-level impact of fertility transitions on schooling quality. As the age structure of countries becomes more favorable, do students receive higher quality education? One could use a variety of approaches to quantify higher quality- the amount of spending per pupil, the average level of teacher training, teacher salaries, etc. However, while these may be important considerations, the data limitations noted above make many of these strategies currently unfeasible.

CHAPTER 3.
DATA & METHODS

The geographic focus of this dissertation is sub-Saharan Africa. Whether comparing the region to other world regions (Question 1), comparing countries within SSA (Question 1&2) or using a single country, Cameroon, as a case study (Question 3), all of the questions investigate the implications of demographic transitions on schooling within sub-Saharan Africa. Below, I provide a description of each of the data sets used in the analyses. After this, I present an overview of the methodological approaches that inform the analyses.

3.1 Data

A range of data sources have been used to investigate the relationship between demographic transitions and schooling in the developing world. Each data source presents both unique opportunities and limitations and the three data sets used in this dissertation are discussed below.

3.1.1 World Bank Development Indicators

To examine cross-country and historical variation demographic and schooling trends, one of the most accessible sources is the World Bank's World Development Indicators Database. The database includes over 800 development indicators for 209 countries running from 1960 to 2008. Indicators range from those related to education, health, and population to the environment, economy, infrastructure, and trade. Having high quality data that permits cross sectional and longitudinal analyses is critical for policymakers and researchers working to set baselines, identify effective public and private strategies, set goals and targets, monitor progress and evaluate impacts.

Some researchers have raised questions over the fact that much of the data reported in the WDI comes from the statistical systems of member countries. Given that many developing countries have severely underfunded statistical collection agencies, the quality of their data may be suspect. However, the bank addresses these issues in three ways. First, they work with individual countries to improve the capacity and effectiveness of national statistical agencies (World Bank 2010b). Second, they often use data from secondary sources (i.e. Demographic Health Surveys, United Nations, etc.) instead of that reported by national governments. In some instances they report data from these sources, while in others they use this data as a "check" on the validity of national statistical agencies reports. Third, unreliable data is simply not reported. Indeed, in 2010, 60 countries currently lack data to track their progress towards achieving the poverty reduction targets established by the Millennium Development Goals (World Bank 2010b). The lack of data for many indicators and years, especially in the case of sub-Saharan Africa, means that researchers have to be careful in their choice of variables and the interpretation of findings. Nevertheless, much research on socioeconomic development is based on cross-county comparisons using WDI data simply because it provides the largest, standardized data set on development indicators.

3.1.2 Demographic and Health Surveys (DHS)

The Demographic and Health Surveys (DHS) are series of national representative surveys fielded over the last two decades in over 75 developing countries, primarily in Africa, Asia, and Latin America. Started in 1984 and funded largely by the United States Agency for International Development (USAID), these surveys collect information on topics such as fertility, family planning, maternal and child health, gender, HIV/AIDS, malaria and nutrition. Beyond the core data on fertility and health, some surveys have collected schooling data that can support detailed analyses of school enrollment (Case et al. 2004; DeRose & Kravdal 2004; DHS 2010; Lloyd et. al. 2000).

DHS data is publically accessible via their website (www.measuredhs.com) and comes in two forms. The first is the unrestricted county micro data files, which are available in a variety of formats. Depending on the type of research to be conducted, the researcher may turn to the household file, which contains a line for each household, or the woman file, which contains a line for each woman age 15-49 in the sample. For research on schooling, the most commonly used file is the household member file, which contains a line for each household member, including children. DHS also disseminates aggregated data from the micro data files via the STATcompiler, HIV/AIDS Survey Indicator Database, STATmapper and HIVmapper. While using these tools is more constraining than working with the micro-data files, they allow researches to quick access to a chosen preset of variables. For example, one can quickly generate tables that show TFR by urban and rural residence for multiple countries across many survey years.

One of the drawbacks of the DHS is that it does not include information on schooling related factors beyond enrollments and attainment. Additionally, there are few community-level variables in some survey years that are pertinent to analyses of schooling (i.e. distance to school, schooling costs, etc.). However, DHS is frequently used by researchers investigating the relationship between demographic factors and schooling for three primary reasons: First, there is relatively detailed information on both family structure and enrollments; Second, the DHS has the large sample sizes, ranging from 5,000 (often seen in the early survey years) to 30,000 (seen in more recent surveys); and third, the replication of DHS across and within several countries creates an appropriate design for historical and cross-national analyses.

3.1.3 Cameroon 1999 Event History Survey

The last study in this dissertation uses fertility and schooling histories collected in 1998/99 in Cameroon. While the rest of the dissertation uses data from a range of sub-Saharan countries, this data in particular provides a host of benefits.

First is the choice of the country itself. In many respects, the country, with 16.4 million residents who reside within the nation's 475,440 square kilometers, has a socio-demographic profile similar to other nations in broader SSA region (World Bank 2010). As seen in Table 3.1, life expectancy in both areas hovers around 46 years, though both infant and child mortality rates are lower in Cameroon. The country also has lower total fertility rates and a more favorable youth dependency ratio. Given this fact, the country serves as an ideal choice for a case study, as it represents a vanguard case with regards to the demographic transition.

Cameroon is also similar to its regional neighbors with regards to other social and economic factors. Though primary enrollment rates in Cameroon are higher (113% versus 93%), rates of completion of primary school are nearly identical (World Bank 2010). Girls are slightly more likely to be enrolled in primary and secondary education in Cameroon, though the difference is rather small (World Bank 2010). In other respects, however, Cameroon differs from the average regional experience, especially in the realms of the economy and population growth & distribution. With regards to the economy, average GNI per capita in Cameroon is high for the region (US$ 810 versus US$ 601), though annual GDP growth is relatively similar. While the percent of land area devoted to agriculture is much smaller in Cameroon (20% versus 44% in SSA), value added agriculture as a percentage of the GDP is higher in Cameroon than in the broader region (44% in Cameroon versus 16% in SSA). In terms of population growth, Cameroon experiences an annual growth rate nearly 15 percent lower in than the regional average, and the distribution of the population is drastically different (World Bank 2010). While only 37 percent of the population resides within urban areas in sub-Saharan Africa, 52 percent of Cameroon's residents are urbanites (World Bank 2010).

Moreover, Cameroon's historical experience with colonialism is similar to that of most Sub-Saharan nations. European presence first arrived in the form of Portuguese traders in the 1870s, who developed significant coastal operations, partially from the acquisition of slaves (USSD 2006). In 1884, the current-day Cameroon became part of a German colony, which was then partitioned by the French and English following World War I (USSD 2006). In 1955, local political organizations, including the Union of the Peoples of Cameroon (UPC), began a struggle for independence from French Cameroon, and by 1960 the movement had proved successful, and the Republic of Cameroon was established. The modern state of Cameroon was created in 1961, when the southern portion of British Cameroon voted to join the Republic to form the Federal Republic of Cameroon (USSD

2006). Thus, in many respects- demographically, economically and socially- Cameroon serves as an ideal case to examine change within the sub-Saharan region.

A second unique aspect of this data stems from the structure of the survey itself. The generating survey, specifically designed to study demographic change in schooling and employment, was based on a national representative sample of 3,369 women aged 15 or more. Using life history calendars, interviewers reconstructed full families including the life histories of these women and their partners, as well as the schooling and employment histories of their biological children, if any. The resulting child sample covered 11,590 "children," for whom interviewers had gathered detailed information about school progression, year by year. The children's histories were used to generate a schooling event-history data set. Records in these subsets consist of person-years and each child could contribute multiple records as long as s/he remained within the risk set. The schooling subset included person-years from school entry until school exit, survey year, or death, whichever occurred first. It covered a total of 52,909 person-years. These data span a lengthy time period, from 1959-1999, and are ideal for examining mother's fertility preferences and subsequent decisions about their children's school enrollment.

Table 3.1 2005 Development Indicators for Cameroon & Sub-Saharan Africa

		CAMEROON	SUB-SAHARAN AFRICA
POPULATION			
	Population growth (annual %)	1.82	2.15
	Population, total (millions)	16.40	726.00
	% Urban	52	37
	Total fertility rate (TFR)	4.8	5.3
	Youth dependency ratio (% of working age population)	76.1	80.4
LAND			
	Surface area (sq. km)	475440	2.43E+07
	Agricultural land (% of land area)*	19.68	44.09
	Agriculture, value added (% of GDP)	44.18	15.97
ECONOMY			
	GDP (current US$)	1.44E+10	5.23E+11
	GDP growth (annual %)	4.3	4.79
	GNI per capita, Atlas method (current US$)	810	601.35
SOCIAL WELFARE			
	Life expectancy at birth, total (years)	45.98	46.22
	Mortality rate, infant (per 1,000 live births)	87.2	100.47
	Mortality rate, under-5 (per 1,000)	149.4	168.19
	Improved sanitation facilities, urban (% of urban population with access)*	63	54.85
	Improved water source (% of population with access)*	63	58.21
EDUCATION			
	Literacy (% of population age 15+)	68	65
	Primary completion rate, total (% of relevant age group)	63.26	61.69
	Ratio of girls to boys in primary and secondary education (%)	86.74	83.58
	School enrollment, primary (% gross)	113.92	92.52

Source: World Bank Development Indicators 2010 , * reflects data from 2002

3.2 Methods

As noted in the in the previous chapter, the bulk of research examining the implications of fertility transitions for children's schooling has focused on the individual level, typically using micro level data in a regression analysis to estimate the impact of sibsize on educational outcomes. Research at the macro level, while more limited, has also has tended to rely on standard regression approaches. However, methodological challenges persist at both levels. Below I discuss these challenges, and then propose a third method (decomposition) that capitalizes on the strengths of both micro and macro approaches.

3.2.1 Macro level approaches

Macro-level approaches have tended to generate findings of interest to both researchers and policy makers alike. This stems from the fact that this method allows one to test hypotheses about the various relationships between policy instruments and policy relevant outcomes. While the outcomes of interest are most commonly economic factors (growth rates, national GDP, etc.) the method can evaluate any outcome of interest (schooling enrollments, infant mortality, total fertility rates, urbanization levels, etc.).

While the appeal of macro-level approaches, typically correlation or regression analysis, is clear, the approach is critiqued on a variety of fronts. First are the data issues. One issue of import, especially in sub-Saharan Africa, is the lack of data, for entire countries or county-year periods. In 2009, of the 48 sub-Saharan countries in the World Banks World Development Online nearly all were missing key data on a variety of economic, social and demographic factors (World Bank 2010). This lack of data may make certain analyses impossible, but more problematically, may also bias the sample of remaining cases.

One of the most oft cited examples of the problems associated with cross-country regression is the Burnside and Dollar (2000) paper, *"Aid, policies and growth."* Using national level World Bank data on foreign aid from all countries with data available at the time of the study, the authors found that "aid has a positive impact on growth in developing countries with good fiscal, monetary, and trade policies but has little effect in the presence of poor policies" (p. 847). Yet, when the paper was replicated with an expanded data set that was available at a later date (Easterly et al. 2004), the effects of aid disappeared. Because of the limitations associated with cross-country regressions, some scholars have suggests that "these results should be viewed as suggestive empirical regularities, not as behavioral relationships on which to measure responses to policy changes" (Levine & Zervos 1993, p. 427)

Beyond this, some measurements may be inconsistent and inaccurate, and "almost without exception, a person with detailed knowledge of a country can quickly identify contradictions between readily available data and what actually happened in that country (Levine and Zervos 1993, p. 426). In country level analysis of schooling in sub-Saharan Africa, the 1999 wave of the Nigerian Demographic Health Survey is nearly always excluded from analyses, as the enrollment levels simply do not match in-country expert's estimates. Additionally, for some macro-level indicators, the information that is provided may not fully capture the broader concept. Indeed, "much of the corruption data that is used in cross-country regressions is based on the perceptions of a relatively small number of domestic and foreign observers in business" (Kanbur 2006, p. 11). Thus, if corruption is manifested in realms not observed by these individuals, the picture is likely skewed.

A second issue pertains to problems of interpretation. Rodrick (2005) maintains that statistically significant regression coefficients may not be strong indicators of policy efficacy due to a host of statistical issues, including outliers, omitted variables, parameter heterogeneity, model uncertainty, and endogenity. With regards to outliers, Easterly (2004) found that the large policy effects uncovered in some macro, cross-sectional regression studies were often driven by instances of extremely "bad" policies. With regards to collinearity, many countries develop a common set of features that co-evolve, but do not represent causal linkages. For example, a good healthcare system and high levels of infrastructure might be correlated, but the fact that these features co-evolved does not imply cause and effect.

Endogenity can also be a problem in these types of analyses, as "for regression to have causal cutting power, the basic assumption must be that variations in the policy are independent of variations in other variables in the regression, in other words, policy variation is exogenous" (Kabur 2005, p. 12). However, if governments are choosing what policies to pursue, then variations are not exogenous, and problems of endogenity emerge. Modeling problems are also evident in this type of research. For example, one could use of linear models to examine the relationship between natural resource base and economic growth. However, it may be misleading to think that this relationship would be the same in the Sudan as in the U.S or even South Africa.

Despite these limitations, Elbers and Gunning (2008), make a compelling five-point argument for the value of macro-level cross-country regressions. First, they contend "what Churchill said about democracy also applies here: cross-country regressions are quite imperfect, until you consider the alternatives" (2008, p.1). At the very least, these analyses restrict the range of possible causal statements that can be made. Moreover, to understand the relationship between macro-level variables there are often few options beyond cross-country regressions. In the context of this dissertation, I seek to understand the relationship between age structure and educational outcomes. Macro-level regression offers the only option other than (1) an experimental design (where countries were randomly assigned different age structures, a clearly impossible option) or (2) case study investigation. While case studies can provide important insights, the approach suffers from the representativeness of the sample (Elbers & Gunning 2008). Additionally, case studies are also not equipped to address the issue of endogeneity. Indeed, there are simply some important macro level questions that cannot be adequately explored without the use of macro-level methods.

Second, they note, macro-level regressions are "are not 'easy to do' and something for 'a rainy afternoon' (Elbers & Gunning 2008 p.1). Researchers are not only aware of the problem associated with macro-level regressions- such as measurement error, reverse causality, outliers, omitted variables, and non-linearities- but many spend their careers developing conceptual and methodological approaches to tackle these issues. Just because some research may not adequately address these issues, does not mean that the method itself is lacking. Indeed, a large portion of research in the fields of demography, economics and sociology is increasingly concerned with the issue of causality.

Third, just because some small changes in data can change findings (as in the case of the Burnside-Dollar paper) it does not mean that the approach is not useful (Elbers & Gunning 2008). Scientific knowledge is built incrementally, and testing the robustness of previous research is core purpose for the academy. Researchers should be as careful and cautious as possible in their work, but "any striking conclusion by a well-known academic will attract the same scrutiny as the Burnside-Dollar paper: if it's wrong it won't stand long" (Elbers & Gunning 2008, p.1).

Fourth, some scholars have critiqued regression analysis for lacking "complexity: if you have to account for all the factors that are of influence on a social phenomenon you can not run your computer programs anymore." (Elbers & Gunning 2008, p.1). This critique transcends issues with macro-level regression to become an epistemological issue about the ability of science to quantify and analyze the social world around us. Most policymakers and researchers would agree that simplification of complexity is necessary to produce generalizable and digestible findings (Elbers and Gunning 2008).

Overall, cross- country regression analyses continue to be a popular choice among researchers as they "permit a more precise view of the consequences of population growth (NRC 1986, p. 55). Moreover, a demonstration of a strong relationship between policy relevant levers and outcomes (i.e. age structure and national enrollments), although still subject to the problems outlined above, gives a suggestion of an important relationship that can be investigated with other analytical methods (Levine & Zervos 1993).

3.2.2 Micro level regression

The bulk of the empirical work, especially over the past 20 years, investigating the fertility-schooling link has been based on micro level evidence, typically from OLS or probit regressions based on cross sectional data (Steelman et al 1999). Thus the standard regression models are typically represented as:

$$edu_i = ß_0 + ß_1 fs_i + ß_2 CH_i + ß_3 FAM_i + ß_4 NE_i + ej$$

where educational outcome/attainment (edu_i) for child *i* is a function of family size (fsi) controlling child characteristics(CHi), family characteristics (FAMi), and other characteristics such as neighborhood factors (NEi). While this approach continues to be used in many analyses, scholars have raised concerns over potential measurement and estimation issues.

With regards to measurement, the bulk of research conduced in settings characterized by nuclear families, establishing a child's number of siblings is, relatively, clear-cut. However, considering the prevalence of polygamy and large, extended families, pinpointing sibsize in sub-Saharan Africa is more complex (Lloyd & Gage-Brandon 1994). Another issue is that sibsize, if estimated from cross-sectional surveys, tends to be treated as a time invariant variable. A better picture would account for the fact that as children age, they typically gain and lose siblings. Not only does actual sibsize vary over a child's life course, but the meaning of an addition sibling is likely to vary based on whether or not that child is still in the household and competing for resources. Indeed, older siblings who have transitioned into the labor market may represent resource boons (Eloundou-Enyegue and Williams 2006).

Researchers have addressed these measurement issues in a variety of ways. On the first point, many surveys in the region now collect a variety of different measures that can be used to calculate a more holistic picture of sibsize. For example, the Demographic Health Surveys reports not only the number of children born to an individual woman (which can be linked to the child to generate a sibsize variable) but a variable on the number of children under the age 18 who are still in the household. Researchers can then either include controls for biological sibsize or household sibsize.

An even more desirable option comes from studies that use longitudinal data to estimate time-varying sibsize measures. While more limited in its availability, this type of data provides information on family size for each index year. Guo and Van Wey (1999) argue that the most rigorous test of the dilution model requires the use of longitudinal data in order to examine the dynamic nature of sibsize composition and schooling outcomes. Using longitudinal data from life-history calendars in Cameroon, Eloundou-Enyegue and Williams (2001) find that, while the time-invariant relationship of sibsize and schooling is only weakly significant (OR=1.03; p<.10), a time varying specification produces a larger and significant beta(OR=1.10; p<.001). Thus, at least in some cases, a time-invariant measure may lead to a substantively different conclusion.

With regards to estimation, several options have been proposed to improve the inferences from regression analysis, namely by addressing issues including as clustering, fixed effects, and endogenity. Clustering arises when observations are taken of subjects who share a common characteristic, such as siblings belonging to the same household. It is also a problem in longitudinal studies where multiple observations are made of the same subject over a period of time. In both cases, observations are correlated with each other, violating a principle assumption of OLS regression. The higher the incidence of correlation among individual observations in a data set, the less unique information each observation contains. This effectively diminishes the sample size. If not addressed, the standard error of the estimates will be off (typically they are underestimated) and significance tests will be invalid. A host of tools have been developed to make the proper adjustments for this issue, including the use of Generalized Estimating Equations (GEE), which can be done using the GENMOD procedure in SAS. This approach provides accurate coefficients and robust standard errors in light of clustering issues (Allison 1999, Norton et al. 1996).

Beyond clustering, micro-level research on the relationship between sibsize and schooling outcomes must also address questions about the issue of "fixed-effects." Here the problem is that researchers often want to make causal inferences from non-experimental data. In the case of an experiment, random assignment to treatment groups makes the groups nearly identical on all possible characteristics of the subjects, including both observable and unobservable factors. However, since randomization is not possible in most social science research, the standard tack has been to identify and measure potentially confounding variables and include them in the regression model. The problem with this approach is that there are unobservable factors likely to be at play. For example, when estimating the likelihood of children's enrollment in school, typical controls might include child's sex, age, parent's education and socioeconomic status, race, etc. However, previous research has established that subtler, and often difficult to measure, sociological processes of norm, aspiration and expectation formation play an influential role in educational and occupational attainment (Buchmann 2002; Giroux 2008; Spenner & Featherman 1978).

Fixed effects modeling provides a strategy to control for potentially important unobservable factors. In the case of schooling research, the fixed effects strategy works essentially by including each family or individual as a control. For example, Guo and Van Wey (1999) used repeated observations of individuals from a longitudinal data set. Parish and Willis (1993) use the family as the locus to examine fixed effects. If their dataset (for illustration purposes) included information on 100 families, one could create 100 dummy variables that indicate membership into family 1, family 2, etc., and then include these in the model. Alternatively, one could use the PHREG procedure in SAS to do the same thing, without all the extra coding. In order to use a fixed effects approach, the dependent variable has to be measured on at least two occasions, and hold the same meaning and metric over time. Additionally, the predictor variables must change in value over time-fixed effects models are essentially useless for estimating the effect of variables that don't change over time, such as gender. Overall, by using this procedure, estimates are improved because the model controls for both standard observed factors *and* unobservable influences that arise out of membership to that particular group (Allison 1999).

While adjusting for clustering and fixed effects are relatively easy issues to address, tackling the problem of endogenity is a decidedly thornier matter. Endogenity is of issue in almost all research on fertility and schooling because of the causal link. While researchers would like to estimate the effect of family size on schooling outcomes, it is possible that an unmeasured influence is jointly determining both of these factors. Most often, issues of endogenity are addressed with instrumental variables (IVs). Broadly, IVs are used to estimate causal relationships when controlled experiments are not feasible. IVs permit more precise beta estimation in cases where covariates are correlated with the error terms. This correlation is often of concern in cases of reverse correlation (where the dependent variable impacts one, or more, independent variables), when relevant independent variables are omitted from the model, or when variables are subject to measurement error. While use of OLS in these situations would produce biased estimates, consistent estimates can be obtained by using an instrumental variable. The IV must be correlated with the endogenous explanatory variable but not with other covariates (Pearl 2000).

The bulk of studies report both the direct estimate and the estimate with the instrumental variable as a means to evaluate the severity of statistical bias due to neglecting the "omitted variable". According to Hausman (1983), if the statistical difference between the OLS and the IV estimates is empirically unimportant, then the null hypothesis that fertility is exogenous to the outcome (i.e. schooling of children) can be accepted. If this is the case, then researchers can focus on the OLS estimation, as it tends to be "more precise than the IV estimate and not overly biased" (Schultz 2005, p. 14). However, the central issue is then to find a variable that can explain a substantial portion of variation in fertility, but does not effect schooling decisions. According to Schultz " the empirical literature on fertility and its consequences on the family is thin, probably because there is no consensus on what variables are valid exclusion restrictions" (Schultz 2005, p. 17).

Many researchers argue that to accurately estimate the effect of sibsize on schooling outcomes "requires a setting where the variation in quantity (e.g. completed fertility or number of siblings) is caused by an exogenous variable which is arguably a valid instrument for fertility and uncorrelated with desired, demanded, or preferred fertility." (Schultz 2005, p.22). Included among the most frequently proposed instruments are those that represent an physiological exogenous shock to fertility that is heterogeneously distributed within the population (twin births, miscarriages, fecundity), exogenous socio-cultural factors that shape family formation preferences (sibling sex composition), and structural factors that exogenously shape a couple's ability to achieve desired family sizes (distance to the family planning center, government regulations).

One of the first studies using an instrument in a developing context comes from India, where Rosenweig and Wolpin (1980) examined the educational consequences stemming from twin births, whose simultaneous arrival was clearly unintended. Using 25 twin births from a sample of 1633 families, they find that the exogenous shock of a twin birth increased fertility by 0.8 and led the family to reduce schooling resources for each child. In China, Rosenweig and Zhang (2006) use a twin instrument to find that "an extra child at parity one or at parity two, net of birth weight effects, significantly decreases the schooling progress… and the expected college enrollment" of children (p. 1). Taking a similar approach and using longitudinal data from Norway, Black, Devereaux and Salvanes (2005), find a negative correlation between family size and education. However, as opposed to Rosenweig and Wolpin's findings, after including a twin births instrument, the family size effects become entirely non-significant. Angrist, Lavy and Schlosser (2005), find similar results using a twin instrument in Israel.

As opposed to a twin birth, where the addition of a child represents an exogenous shock, Maralani (2008) uses data on miscarriages as an instrument, as miscarriages are "involuntary, spontaneous fetal deaths that reduce the number of conceptions that result in live births, and therefore represent lost fertility exposure time" (p. 709). Using longitudinal data from Indonesia, she finds that, in urban areas, the association between sibsize and schooling was positive among older cohorts, but negative for more recent cohorts (Maralani 2008). Including the miscarriage instrument to address endogenity resulted in little change in the findings. Rosenzweig and Schultz (1985) use data from the Malaysian

Family Life Survey (1971 to 1976) on contraceptive practice and conception rate of a couple to infer biological fecundity. This measure of fecundity uses a similar logic to the twin approach, but represents a continuous variable that estimates a couple's reproductive potential dependent on their contraceptive behavior. Using this as an instrument on child's schooling, they find that all the estimates of the effects of exogenous fertility on child's schooling are smaller than they would be without the use of the instrument.

Sex composition has also been proposed as an instrument, though the approach only has explanatory power to predict fertility in societies where parents have a sex preference for children. Conley and Glauber (2005) use data from the 1990 PUMS and find that using a sex-mix instrument results in a smaller, though still significant and sizable estimate, of the relationship between sibsize and schooling than the estimate generated by a traditional OLS approach. Using the Korean Household Panel Study (1993-1998), Lee (2008) creates an instrument from data on whether or not the first birth is a girl to examine completed fertility, as data shows that if a women's first child is a girl, she is more likely to continue to a second birth. While the OLS estimate of sibsize on the educational investment per child is -.5, this shrinks to -.3 with the use of the instrument. Jensen (2005) takes a similar approach in India, and finds that the OLS estimate of the effect of an additional sibling on years of schooling is -1.2, whereas the estimate generated when using a sex composition instrument is -0.69. While, for these cases, the use of the sex instrument results in a quantity-quality tradeoff that is still evident, Angrist, Lavy and Schlosser (2005), find no significant evidence of a tradeoff when using a sex composition instrument in Israel.

Various structural factors that exogenously shape a couple's ability to achieve their desired family size have also been used as instruments. A recent study in Vietnam used data on distance to family planning centers, number of visits per month by mobile family planning team, and government regulations as instruments in modeling the impact of sibsize on school enrollment. However, the authors find that the impact of sibsize on school enrolment is strongly negative (from -0.5 to -1.0 per sibling) and significant across instruments (Rogers 2010).

However, while all of these options represent a potential source of exogenous fertility, they tend to have both conceptual and practical problems. While the work using miscarriages is promising, it hinges on the availability and quality of the reported data.

With regards to twins, there are two primary reasons why such an assumption might be problematic. First are the health issues stemming from biological differences between twins and non-twins. Twins experience shorter gestational periods, more complicated deliveries, and lower birth rates and therefore tend to be less healthy, on average (Rosenzweig & Wolpin 1980). These health issues may impact the human capital investment decisions made by parents.

Second, while the occurrence of a twin birth might represent a short-term shock to fertility, it's not the same as another child being added to a woman's completed fertility. Instead, women make adjustments to future fertility decisions to account for the additional twin. If twins were truly an exogenous shock, then the completed fertility of women with twins should always average one child more. Instead, the completed fertility of women who have twins is less than one, and has declined over time in studies in the United States (Bronars & Grogger 1994; Jacobsen, Pearce, & Rosenbloom 1999). The use of a twinning instrument is then especially problematic in developing countries, given the high total fertility rates.

The use of sex composition as an instrument poses different problems, namely that it forces arbitrary cultural and economic assumptions about parental preferences for sex composition. Additionally, sex composition is likely to be less important in determining ultimate sibsize in settings where progressing to a higher parity only becomes an issue after the fourth child or so (witness the data on ideal family size in sub-Saharan Africa, which is generally above four or five children).

Moreover, there is still a lack of consensus on the actual effect of IV estimates. As noted above, the use of a twinning instrument resulted in a negative relationship between sibsize and schooling in India, and conversely wiped out evidence of this relationship in the widely cited study by Black, Devereux, and Salvanes (2005). Moreover, while Black, Devereux, and Salvanes (2005) find that "there is little if any family size effect on child education; this is true when we estimate the relationship with controls for birth order or instrument family size with twin births," (p. 697) Mogstad and Wiswall's (2010) more recent study using the same data and instruments finds that "that the conclusion of no effect of family size is an artifact of the linear specification, masking substantial marginal family size effects" (p. 1). In sum, there appears to be little consensus in the field as to 1) what constitutes a "good" instrument; 2) which type of instrument in the most ideal; and 3) the expected impact of each instrument.

3.2.3 Aggregation and decomposition approaches

While macro-regression approaches lack the methodological rigor sought by researchers, micro-level regression results may be unpalatable to policymakers. The ideal approach would then be to bring the rich detail and rigor of micro level estimates to the macro social relevance.

Micro level analyses can help us understand the mechanisms underpinning individual or household decision-making. However, for reasons discussed in Chapter 2, they are not always ideal tools to investigate broad social change. Conversely, macro-level approaches have the benefit of conducting analyses at the more policy-relevant level, but such analyses can obscure the details of individual processes and inequalities within societies. An ideal analytic approach would be one that merges the rich detail of the micro approach with the policy relevance of the macro approach. One option to achieve this is to use multi-level modeling, which allows a researcher to evaluate how broader conditions (i.e. the socioeconomic environment) shape individual decision-making. Another approach, explored in detail here, is the use of aggregation and decomposition (Eloundou-Enyegue & Giroux 2010).

One of the most challenging problems confronting researchers studying social change is the extent to which relationships between variables represent causal connections, as opposed to mere correlations. Given this fact, decomposition is an ideal tool. Even if it does not identify the ultimate cause of change, it offers a partial solution by locating "sources" of social change, i.e. the groups and processes (composition or behavior) that are the main drivers of change. Switching from a focus to the "sources" of change as opposed to the "causes" means that the researcher is able to establish the main driver of change, without a full accounting for what caused the change. In so doing, it reduces significantly the margin of error in understanding social change.

Social processes that are amenable to decomposition analysis are those that meet three criterions. First, they muse be quantitative, or capable of being measured by numbers. Ideal processes are those that can be captured by an average, percentage or ratio, as opposed to qualitative phenomena. Second, the processes must represent an aggregate phenomenon, or a process that can be summarized by an aggregation of individual level experiences. Here, something like Total Fertility Rates, which represent a collection of individual level experiences, would be amenable to decomposition analysis. Conversely, a study of national immigration laws, which have no equivalents at the individual level, would not be suitable. Lastly, the phenomenon studied must be gradual. The approach would not be well suited for the study of change that resulted from a rare or cataclysmic event. Therefore one could use the approach to study generic changes in schooling enrollments, but not the impact of the nuclear meltdown in Japan on migration patterns.

The most basic decompositions apportion change into two principal sources: (1) the effect of the composition of a population and (2) the effect of the behavior of individuals within a population. The "effect" of the compositional component stems from a change in the total size of various social sub-groups of the population. Thus, factors like differential infant morality, fertility, or migration patterns across social strata would change the number of individuals in each category. For example, national levels of schooling could decline due to an reduction in fertility among poor women-- if children from poorer households are less likely to be enrolled in school, growth in fertility among the poor would, automatically, increase the number of children residing in poor households, relative to the rest of the population and negatively impact national levels of schooling attainment. As society is composed of different sub-groups, change in the relative representation of each sub-group will impact social change. The behavioral component operates differently. This component represents real change in the behavioral patterns of different sub-groups. Thus, if schooling enrollments among the poor increase, all else equal, national levels of schooling will increase as well.

Thus, in the case of schooling, one could imagine scenarios where national gains are driven by a decrease in the number of children from poor families (a composition effect) or by poor children increasingly attending school (a behavioral effect). Given this example, one can easily see that understanding how social change unfolds is critical given that there are very different policy implications for each component. Changes in the number of children from poor families may be the result of family planning policies, while increasing school access to poor children might be the result of the reduction of tuition. Moreover, decomposition analysis does not require an "either-or" strategy—enrollment gains are either the result of behavioral OR composition change—but instead allows for the two effects to operate simultaneously. Indeed, the advantage here is that one can quantify the relative importance of each of the two processes.

While the most basic decomposition focuses on these two (compositional and behavioral) sources of change, one can further decompose each component term. For example, in the case of schooling, the number of children in poor families (the composition component) can decline as a result of a declining number of poor families (as a result of economic expansion, for example) or a decline in the fertility of poor families. For the behavioral component, the change in average behavior may impact all groups equally (i.e. enrollment rates rise among all SES groups) or may impact groups differentially (i.e. enrollment rates rise only among the most educated). Understanding the precise source of change allows the researcher to craft a more refined explanation of the social change.

While decomposition is not the only, and not always the ideal approach to explain social change, it does represent an often-overlooked tool that can help understand macro level social change in new ways. Moreover, decomposition is a compelling tool that, both alone and combined with other approaches, can help policy makers strategize on where best to allocate limited resources. When presented with a host of programmatic options, policy makers can rely on the decomposition findings to determine what policy levers will have the greatest impact on a specific social issue.

In reality, there is likely no "best" method to investigate any one social phenomenon. Instead, science is best served by the use of multiple methods, across a range of contexts and historical periods, investigated by a host of scholars with varying theoretical viewpoints. The evidence generated by varying approaches can then be used to hone-in-on and triangulate the nature of relationships between social phenomena. With this in mind, I proceed with three different analyses that contribute to our understanding about the relationship between fertility transitions and schooling.

CHAPTER 4.
NATIONAL LEVEL DIVIDENDS FROM FERTILITY TRANSITIONS

4.1 Background

The dividend framework proposes that as countries progress through their demographic transitions, improvements in dependency ratios will create the potential for a demographic dividend. While, as noted above, many studies have examined the dividend in terms of macroeconomic gains, fewer have considered the relevance of these transitions for schooling. Additionally, many have simply used standard cross-country regression to estimate the impact of the change in the age structure with various socioeconomic outcomes. This analysis expands on previous work in several ways: First, it examines the relationship between fertility transitions (changes in age structure) and schooling outcomes at the national, policy relevant level. Second, it bypasses many of the problems associated with using cross-country regression by 1) conceptualizing the bonus as the change in schooling outcomes that occur between two time periods and 2) decomposing this change to quantify the importance of fertility transitions, as opposed to other factors. Third, it considers not only the variation in schooling, but also formally estimates the inequality in schooling. Lastly, it uses a decomposition approach determine the substantive drivers of changes in inequality.

As noted in Chapter's 1 and 2, the potential for fertility transitions to boost schooling is a timely question, especially for policymakers concerned about development in sub-Saharan Africa. Goal 2 of the Millennium Development Goals seeks to "ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling," there is policy interest in any factor that can help achieve this goal. Globally, significant progress has been made towards achieving this goal, with a global net enrollment ratio of greater than 90 percent. Yet enrollment gains in SSA continue to lag behind other global regions. In 1999, sub-Saharan Africa was home to 43 percent of the world's children currently not in school in 1999, and that number rose to 46 percent by 2008 (UN 2010).

Additionally, despite some gains in enrollments, it's unclear as to whether enrollment gains in sub-Saharan Africa are qualitatively similar to those experienced in other world regions. There are two substantively different reasons to investigate schooling quality. The first stems from a discussion presented in Figure 6 of Chapter 2. Here we made the point that the conversion of the fertility decline to gains in schooling enrollment does not happen automatically. The more mechanical steps are 1-4, whereby an improving age structure is transformed into greater resources available per child. The ability of countries to parlay these resources into higher levels of enrollment depends on a range of policy factors, many of which will vary from country to country. Thus, analyses that seek to quantify the magnitude of the dividend itself should estimate the resource boost associated with fertility declines, captured here as the average national schooling expenditure per child, as apposed to enrollments.

A second reason to focus on educational quality is a more generalized concern over the potential for global and regional divergence in educational quality itself—one could imagine a convergence in outcomes (quantity) without a concurrent convergence in resources (quality). Although the Millennium Development Goals recognize that "achieving universal primary education means more than full enrolment…it also encompasses quality education" there is little systematic monitoring of variation in quality. This is problematic on three fronts. First, at the national level, international targets and standards become less meaningful if there is large variation in the quality of educational experiences. It also might mask the need for countries with lower quality to reallocate money towards education or to seek funds from international sources. Second, research has found that "poor school quality reduce[s] school enrollments, encourage[s] dropout, and compromise[s] learning" (Lloyd et al. 2005). Thus, while we may see convergence in primary levels of schooling, this may not translate into convergence at higher levels if there is a large variation in quality. Evidence of variation in quality is important, as previous studies (Behrman & Birdsall, 1983; Behrman et al. 1996; Glewwe, 1999) examining the impact of school quality on labor market outcomes have found that "deepening education by increasing its quality is as important as expanding education" (Hannum 2005). Third, at the individual level, variation in quality is problematic if children are increasingly "growing up global" (Lloyd 2005). Research finds that children are coming of age in a world characterized by shared aspirations and by an emulation of the perceived consumption standards of western middle classes (Gerke 2000; Radhakrishnan 2008). Not only are lifestyle expectations converging, but differentiation in educational quality may critically impact nations seeking investments. In a globalized economy, a poorly educated workforce may reduce interest in international investments, thus spurring fewer possibilities for economic growth and development.

Despite the concern over educational quality, previous research has tended to focus on enrollments, largely due to lack of data on indicators of educational quality. Here we use World Bank data to construct an, admittedly crude, indicator of educational equality at the national level: average educational expenditures per child. We then use this measure to ask the following questions:

1) What are the global trends in schooling resources per child? How does sub-Saharan Africa compare?

2) To what extent are fertility transitions, via changes in age structure, driving changes in educational expenditures in various world regions? What about in SSA?

3) How has inequality in schooling resources between world regions between 1990 and 2005? How do trends look within SSA?

4) What were the main drivers of changes in global schooling resource inequality?

4.3 Data and Methods

4.3.1. Data

The analyses use national level data from the World Bank Development Indicators database (2010). This dataset is an ideal source, as it includes historical indicators of population size, age dependency, policy commitment to education, and economic performance from a range of countries. Population size measures the total number of people residing in the country. Age dependency was measured by the ratio of the 0-14 population (youth) to the 15-64 years (working) age group[6]. Data on Gross National Income served as the indicator for national income. The share of Gross National Income (GNI) allocated to education measured resource commitment (allocation) to children's education. Although the World Bank database covers nearly five decades (1960-2008), I largely focused on years between 1990 and 2005 both because this period covers the early stage of African fertility decline and because, both in SSA and globally, the number of cases became sparse for years prior to 1990. Missing data was a problem for the analysis, but the bulk of missing data is from relatively small countries. A list of all missing data by region is included in Appendix Table 4.1.

4.3.2 Methods

According to resource dilution theory, inequality among children stems from disparities in parental resources, the share of resources devoted to children, and the number of siblings (Blake 1981). Despite potentially problematic assumptions[7], this model continues to inform much of the research on the implications of demographic transitions for children's human capital. Applying the tenants of dilution theory at the national level, the average schooling resources per pupil (*r*) then depends on the total national resources (G), the share of these resources allotted to education (k), and the size of the school age

[6] A more ideal measure would account for "real" dependency ratio- or the number of children in the 0-14 age range divided by the number of *employed* adults. Moreover, such a measure would also account for the working status of children. However, data on both indicators was sparse and would have resulted in excessive numbers of missing cases.
[7] As discussed in Chapters 2 and 3.

population (n). Roughly r= Gk/n.[8] Taking age dependency (p) as the proportion of children compared to the total working age (adult) population (n/N) then:

$$r = gk / p \qquad (1)$$

where g is (G/N), the national income over the total adult population

The historical change in the schooling resources per capita thus depends on trends in age dependency, the economy and the public budget allocation to education (as reflected in p, g, and k respectively,). This change can be decomposed as follows:

$$\Delta r \cong -[(\underbrace{\overline{kg / p^2}}_{\text{Age dependency effect}}) * \Delta p] + [(\underbrace{\overline{k / p}}_{\text{Income effect}}) * \Delta g] + [(\underbrace{\overline{g / p}}_{\text{Budget effect}}) * \Delta k] \qquad (2)$$

While the gain in (2) is measured in absolute terms, it can also be evaluated in relative terms, e.g., vis-à-vis other areas of the world. The computations remain the same except all four parameters (r,k,p,and g) are calculated relative to world averages. Such comparisons show how various countries gain or lose ground vis-à-vis the world as a result of demographic transitions. This global inequality can be expressed, as usual, as a weighted function of the relative resource endowments of world countries (Firebaugh 1999; Firebaugh & Goesling 2004).

[8] Indeed, R is a rough measure, as it simply divides educational expenditures by the population age 0-14. In many contexts children stay in school past this point, and few national governments provide education to very young children. However, given the need to compare spending across a wide range of policy environments, this is a relatively stable and comparable measure.

For instance, one can take the Mean Log Deviation (MLD) as a measure of inequality[9]:

$$I_R = \sum_j w_j \ln(1/r_j) \qquad [3]$$

where I=global inequality; w_j represent the populations of individual countries as shares of the world population.

With this, the change in global inequality can be decomposed as in (4) below, a breakdown that isolates, among others, how age dependency in various world regions affect global inequality in children's schooling resources.

$$\Delta I_R \cong \underbrace{[\sum_j (\overline{r_j} - \overline{\ln r_j})\Delta w_j]}_{\boxed{\textit{Pop size effect}}} - \underbrace{[\sum_j (\overline{w_j r_j} - \overline{w_j})\Delta \ln(p_j)]}_{\boxed{\textit{Age dependency}}} + \underbrace{[\sum_j (\overline{w_j r_j} - \overline{w_j})\Delta \ln(g_j)]}_{\boxed{\textit{Income effect}}} + \underbrace{[\sum_j (\overline{w_j r_j} - \overline{w_j})\Delta \ln(k_j)]}_{\boxed{\textit{Allocation effect}}} \qquad [4]$$

4.4 Findings

4.4.1 Estimating the dividend

Figure 4.1 provides an overview of global trends in educational quality for all world regions (Appendix Table 4.1 provides data on all countries). Using equation (1), I estimate the schooling resource per child (r), and change in (r), for various world regions. Unsurprisingly, educational quality varies substantially between regions, with North America ($9518) and Europe ($8006) spending the most per pupil in 2005. Sub-Saharan

[9] To assess the robustness of the MLD measure, I also estimate the Squared Coefficient of Variation (CV):

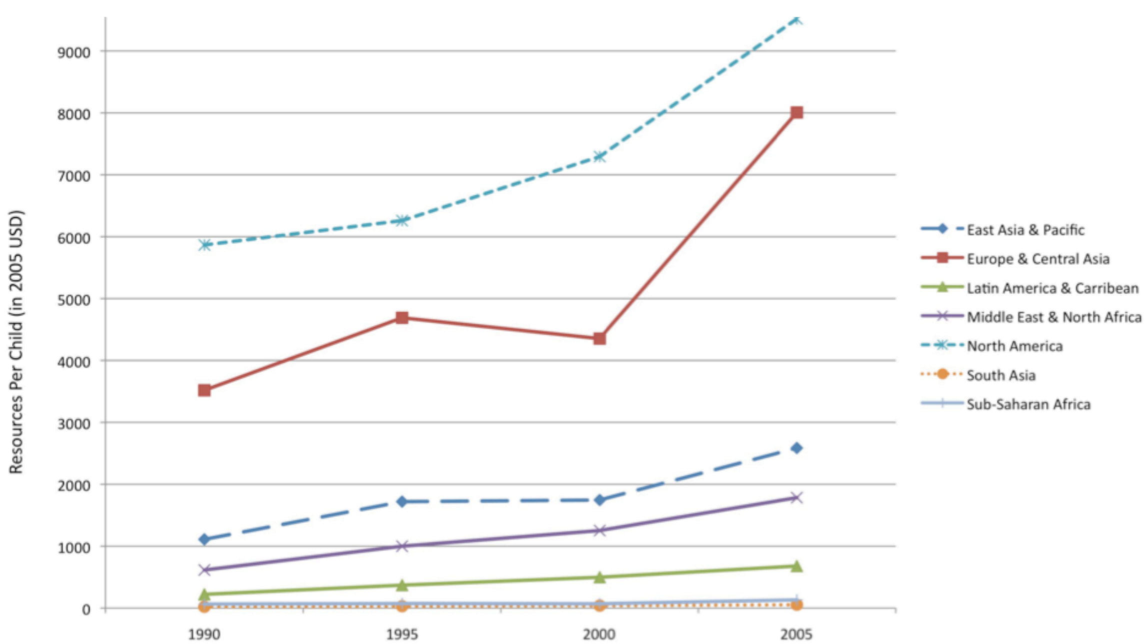
$$I_R = \sum_j w_j (r_j - 1)^2$$

and the Theil:

$$I_R = \sum_j w_j (r_j (\log r_j))$$

Africa registered the lowest level of educational spending ($68), with the exception of South Asia ($34)[10]. Increases in spending between 1990 and 2005 ranged from a high of 207% in Latin America and the Caribbean to a low of 62% in North America. Sub-Saharan Africa had the second lowest increase in spending, at 104%.

Figure 4.1 Global change in public educational resources per child, 1990-2005



4.4.2 Drivers of the dividend

Because the total change in r reflects the combined effects of age structure, economic performance and public commitment to children's education, it is useful to

[10] It's important to note here that the educational expenditures per child do not actually equate to what governments spend to education the average child. The latter depends on the number of children enrolled. Thus, in the case of North America, the figures are likely relatively equivalent, as most children are enrolled in school. However, in sub-Saharan Africa, the fact that many children are not enrolled in schools means that average resources per child (RPC) is lower than the actual government expenditure to educate a child.

decompose these various contributions. As evident in Table 4.1, in nearly every region, one finds that the dominant driver of the gains in r was associated with improved economic performance (g), ranging from 49 to 119 percent.

However, age dependency (p) also plays a critical role, accounting for anywhere between 25 to 45 percent of the change in r across global regions. This fact highlights the importance of effective population policy, as across the globe reductions in age dependency are playing a key role in improving the quality of children's education. Changes in the levels of social commitment plays the smallest role in all regions except for North America, which experienced a decline in social commitment of education. Without this decline, gains in income and a more favorable age structure would have further increased the educational expenditure per child.

Clearly sub-Saharan Africa lags behind the global average in educational expenditures per child. However, while there is an average gain of $68 per child between 1990 and 2005 within the region, this mean conceals substantial variation across countries. Gains in r approach or exceed $150 (i.e., roughly $10 per year) in six countries, including Botswana ($960.8), Mauritius ($512.5), South Africa ($390), Swaziland ($239.6), Cape Verde ($239.5) and Lesotho ($148.4). Sixteen countries saw more modest gains (ranging between $4 to $33) while fourteen countries experienced some decline. The greatest losses in r occurred in Zimbabwe (-$96.5) the Congo (-$73.3), Togo (-$25), Cote d'Ivoire (-22.4), and Mauritania (-$21). These nominal changes are put in better perspective when expressed in percentage terms. In that light, even though Cape Verde's nominal change, for instance, is smaller than South Africa's, it is more impressive in percent terms (353% versus 86%).

Regionally, about two-thirds (67%) of the gain in r was associated with improved economic performance, and about a quarter (25%) with changing age structure, and the rest (8%) with increased public commitment to education. This regional evidence of a demographic bonus is especially compelling considering that current declines in fertility are still modest. I then evaluate within region variation the demographic bonus. Overall, while improved economic performance was the main reason for the aggregate gain in r, the change in age structure was an important factor as well. In countries experiencing large gains (~ $150 or more), the contributions of age dependency were all positive and substantial, ranging from 17% in Lesotho to 53% in South Africa. Similarly, in 13 of the 14 countries experiencing declines in r, age dependency broke the decline even though it was not sufficient to stem it. In sum, the trends in age dependency during this period generally worked to boost children's resources, even if the contribution was, at times, insufficient to overcome adverse trends in the economy or public commitment to education. In addition to age dependency and economic performance, Table 4.1 highlights the importance of social commitment to education. Countries that achieved the largest gains in r did so through balanced contributions of economic growth, reduced dependency, and improved public commitment to education. South Africa and Angola are notable exceptions where r grew despite a declining public commitment to education. In countries where r declined, the culprits were economic downturns (e.g. Zimbabwe) or reduced public commitment (Congo, Togo, and Côte d'Ivoire) or both. The central point here is that reductions in age dependency were an important factor in spurring growth or braking the decline in educational resources for children.

Table 4.1. Global Trends & Sources of Change in Educational Resources per Child, 1990-2005

	1990 g	2005 g	1990 k	2005 k	1990 p	2005 p	1990 r	2005 r	Δ r	Age dependency	Income	Social Commitment
East Asia & Pacific	9757	18234	0.040	0.040	0.53	0.42	***$ 1,110***	***$ 2,586***	***$ 1,475***	28%	71%	0%
Europe & Central Asia	20379	39322	0.048	0.051	0.35	0.28	***$ 3,518***	***$ 8,006***	***$ 4,488***	26%	68%	6%
Latin America & Caribbean	3276	6252	0.034	0.041	0.66	0.51	***$ 221***	***$ 680***	***$ 458***	26%	56%	18%
Middle East & North Africa	7914	14466	0.046	0.049	0.71	0.46	***$ 615***	***$ 1,784***	***$ 1,169***	45%	49%	6%
North America	32248	56406	0.058	0.048	0.32	0.28	***$ 5,866***	***$ 9,518***	***$ 3,652***	25%	119%	-43%
South Asia	590	1080	0.022	0.023	0.71	0.56	***$ 20***	***$ 54***	***$ 34***	30%	65%	5%
Sub-Saharan Africa	1211	1659	0.036	0.037	0.88	0.78	***$ 65***	***$ 133***	***$ 68***	25%	67%	8%
Botswana	5148	8580	0.051	0.085	0.86	0.57	*$ 307*	*$ 1,268*	*$ 961*	34%	33%	33%
Mauritius	3372	7348	0.033	0.038	0.44	0.36	*$ 255*	*$ 767*	*$ 512*	20%	68%	12%
South Africa	5294	7892	0.058	0.053	0.67	0.49	*$ 453*	*$ 843*	*$ 390*	53%	62%	-14%
Swaziland	2760	4376	0.045	0.064	0.98	0.76	*$ 126*	*$ 366*	*$ 240*	26%	42%	32%
Cape Verde	1988	3630	0.033	0.059	0.98	0.70	*$ 68*	*$ 307*	*$ 240*	27%	37%	36%
Lesotho	1154	1539	0.042	0.096	0.89	0.73	*$ 55*	*$ 203*	*$ 148*	17%	23%	60%
Kenya	725	967	0.063	0.063	1.01	0.78	*$ 45*	*$ 78*	*$ 33*	48%	51%	1%
Ghana	729	845	0.028	0.047	0.83	0.70	*$ 25*	*$ 57*	*$ 33*	23%	18%	59%
Angola	1545	3120	0.044	0.030	0.95	0.90	*$ 72*	*$ 102*	*$ 31*	16%	206%	-123%
Comoros	1128	1094	0.039	0.042	0.91	0.66	*$ 49*	*$ 70*	*$ 21*	91%	-8%	17%
Mali	601	828	0.023	0.035	0.86	0.84	*$ 16*	*$ 35*	*$ 18*	4%	42%	54%
Benin	740	1019	0.033	0.036	0.89	0.82	*$ 27*	*$ 45*	*$ 18*	17%	64%	19%
Burkina Faso	697	745	0.027	0.043	0.95	0.88	*$ 20*	*$ 36*	*$ 16*	13%	11%	76%
Mozambique	341	563	0.038	0.041	0.93	0.84	*$ 14*	*$ 28*	*$ 14*	16%	72%	12%
Sierra Leone	259	412	0.024	0.039	0.77	0.77	*$ 8*	*$ 21*	*$ 13*	0%	49%	51%
Tanzania	312	685	0.024	0.024	0.89	0.85	*$ 8*	*$ 19*	*$ 11*	6%	94%	0%
Uganda	484	652	0.035	0.040	0.98	1.03	*$ 17*	*$ 25*	*$ 8*	-13%	76%	37%
Madagascar	503	535	0.020	0.027	0.86	0.84	*$ 12*	*$ 17*	*$ 6*	5%	16%	79%
Malawi	385	424	0.026	0.035	0.92	0.93	*$ 11*	*$ 16*	*$ 5*	-2%	24%	78%
Zambia	738	1129	0.026	0.021	0.89	0.90	*$ 22*	*$ 27*	*$ 5*	-9%	214%	-105%
Chad	556	936	0.012	0.012	0.91	0.90	*$ 8*	*$ 12*	*$ 5*	2%	109%	-10%
Cameroon	1706	1655	0.031	0.029	0.89	0.76	*$ 59*	*$ 63*	*$ 4*	229%	-46%	-83%
Guinea	785	651	0.018	0.020	0.85	0.81	*$ 17*	*$ 16*	*$ (1)*	-163%	585%	-322%
Burundi	381	189	0.033	0.051	0.88	0.74	*$ 14*	*$ 13*	*$ (1)*	-123%	549%	-326%
Congo, Dem. Rep.	451	234	0.009	0.009	0.94	0.96	*$ 5*	*$ 2*	*$ (2)*	3%	97%	0%
Sudan	795	1175	0.021	0.009	0.83	0.73	*$ 20*	*$ 14*	*$ (6)*	-35%	-113%	248%
Rwanda	747	477	0.035	0.031	1.02	0.77	*$ 26*	*$ 19*	*$ (7)*	-93%	153%	40%
Ethiopia	478	315	0.028	0.024	0.87	0.86	*$ 15*	*$ 9*	*$ (7)*	-1%	71%	30%
Niger	634	522	0.032	0.023	1.01	1.00	*$ 20*	*$ 12*	*$ (8)*	-2%	38%	64%
Gambia, The	599	504	0.032	0.020	0.79	0.79	*$ 24*	*$ 13*	*$ (11)*	0%	28%	72%
Central African Republic	920	589	0.021	0.016	0.81	0.76	*$ 24*	*$ 12*	*$ (12)*	-10%	65%	45%
Mauritania	1049	1131	0.045	0.022	0.84	0.72	*$ 56*	*$ 35*	*$ (21)*	-35%	-16%	151%
Cote d'Ivoire	1389	1475	0.070	0.047	0.85	0.75	*$ 114*	*$ 92*	*$ (22)*	-57%	-27%	184%
Togo	799	625	0.052	0.025	0.90	0.75	*$ 46*	*$ 21*	*$ (25)*	-25%	32%	93%
Congo, Rep.	1818	2401	0.067	0.023	0.84	0.75	*$ 145*	*$ 72*	*$ (73)*	-16%	-42%	159%
Zimbabwe	1593	467	0.079	0.069	0.90	0.74	*$ 140*	*$ 43*	*$ (97)*	-18%	105%	13%

Data Souce: World Bank 2010. Detailed information on countires included in each region can be found in Appendix Table 1

4.4.3 Inequality and the dividend

Results from Table 4.1 suggest vast regional, and intraregional, differences in total levels of educational expenditures per child. However, while easy to calculate and interpret, simply considering differences in expenditures is not the only to capture changes in global educational expenditures among all the world's children. From a policy standpoint, just looking at the differences in expenditures between nations does not allow one to consider the relative size of each nation, and this can bias policy inference (Bongaarts 2005).

Figure 4.2 Global decline in inequality (MLD, Theil, and CV2) in public educational resources per child, 1990-2005

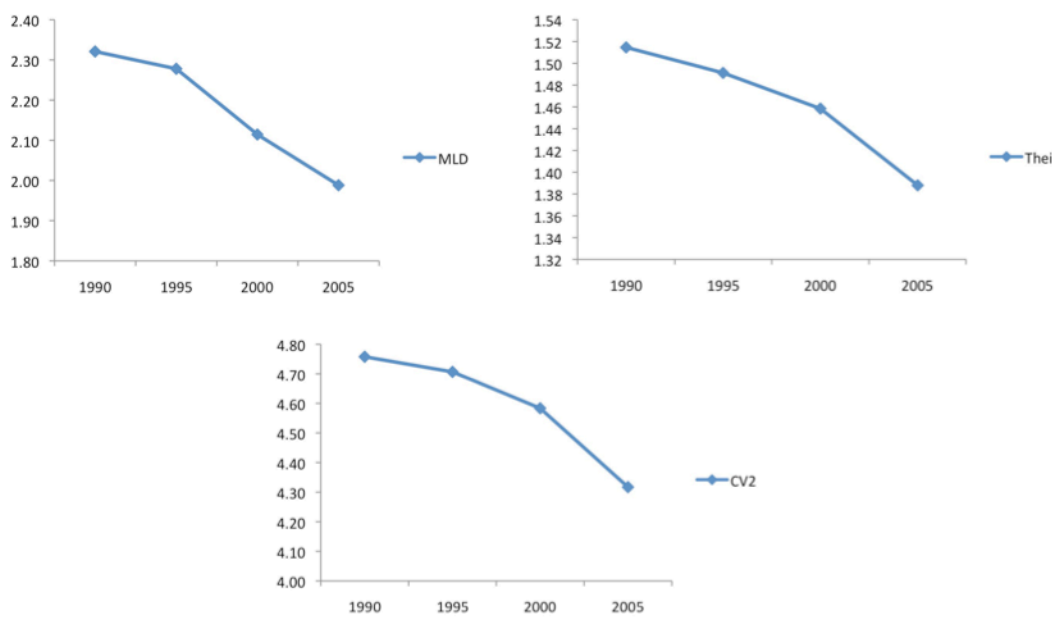
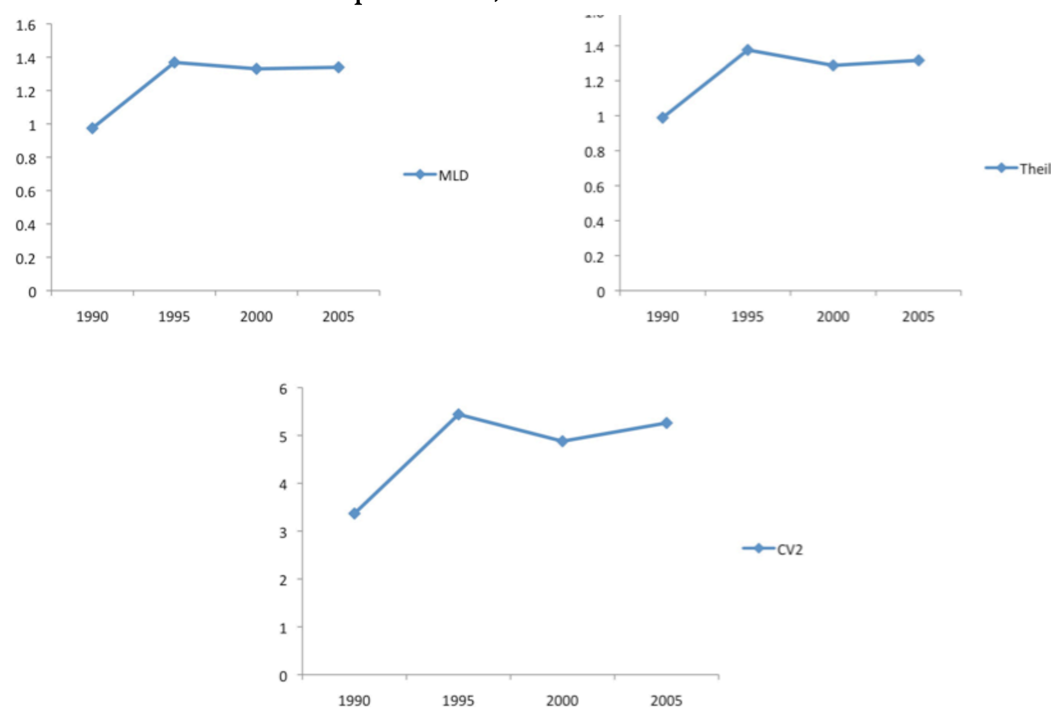


Figure 4.2 suggests modest declines in inequality between 1990 and 2005. When using the CV, inequality declined from 4.76 in 1990 to 4.32 in 2005, or about 9.3%. When measured by the Theil, inequality dropped 8.4 %, from 1.51 to 1.39. The MLD records the steepest decline in inequality, with a 14.3% drop from 2.32 to 1.99. Overall, regardless of the measure, we are seeing some evidence of global convergence in the educational

resources available to children. While at a slower rate, this convergence echoes the global convergence in GDP per capita described by Firebaugh and Goesling (2004).

Figure 4.3 Sub-Saharan Africa increase in inequality (MLD, Theil, and CV2) in public educational resources per child, 1990-2005



Interestingly, while global convergence is evident, Figure 4.3 suggests increasing inequality within the SSA region. Between 1990 and 2005, inequality between sub-Saharan nations increased anywhere from 33%, as measured by the Theil, to 38%, as measured by the MLD, to 56%, as measured by the CV2. These findings reflect similar evidence of divergence in GDP as noted by Kandiwa (2006).

4.4.4 Drivers of the inequality in the dividend

Turning back to global changes in resource inequality, the next step is to assess the drivers behind decline in global resource inequality over the 15 years. The upper most part of Table 4.2 provides a summary of the substantive and regional drivers[11]. Using the decomposition formula (4) presented above, we decompose the .32 unit decline in the MLD to assess the relative importance of each substantive driver (population size, age dependency, income, and allocation) by world region. The main drivers of change are highlighted in grey, and the dashed border notes cases that contribute to reducing inequality. Globally, a large portion of the decline in inequality was driven by changes in East Asia and the Pacific- where relative declines in population size (-.06), improvements in the age dependency ratio (.06), gains in income (-.34), and relative changes budgetary allocation for schooling (-.06) converged to reduce the global inequality in educational quality. Improvements in age dependency (.05) and income (-.14) in South Asia also reduced global inequality, while growth of the total population size (.05) worked towards increasing inequality. Similarly, larger relative income growth in Europe & Central Asia (.16) and North America (.17) would have resulted in increased inequality if not for other factors at play. Sub-Saharan Africa played a relatively small role in shaping change in global inequality in educational expenditures, but the large gains in population size (.07) served as an important factor in increasing inequality.

[11] Regions include East Asia & Pacific, Europe and Central Asia, Latin American and the Caribbean, Middle East & North Africa, North America, South Asia, and sub-Saharan Africa. See Appendix Table 4.1 for a complete list of countries by region.

Table 4.2 Decomposition of global and African educational resource inequality among children into subsantive and regional drivers, 1990-2005.

Δ INEQUALITY (MLD)	**WORLD**	Share of total decline in resource inequality associated with changes in: *Population Size*	- *Age Dependency*	+ *Income*	+ *Allocation*	**Regional Total**
-0.32	East Asia & Pacific	-0.06 *20%*	0.06 *-18%*	**-0.34** ***105%***	-0.06 *18%*	**-0.52** 161%
	Europe & Central Asia	-0.04 *14%*	-0.02 *5%*	0.16 *-51%*	0.02 *-6%*	**0.15** -48%
	Latin America & Carribean	0.00 *-1%*	0.02 *-5%*	-0.04 *11%*	-0.02 *7%*	**-0.07** 22%
	Middle East & North Africa	0.01 *-2%*	0.02 *-5%*	0.00 *2%*	0.00 *1%*	**-0.02** 6%
	North America	-0.01 *3%*	-0.02 *6%*	0.17 *-54%*	-0.01 *3%*	**0.17** -54%
	South Asia	0.05 *-17%*	0.05 *-17%*	-0.14 *43%*	0.03 *-9%*	**-0.11** 35%
	Sub-Saharan Africa	0.07 *-23%*	0.01 *-2%*	0.00 *1%*	0.01 *-2%*	**0.07** -21%
	WORLD TOTAL	**0.02** -6%	**0.12** -36%	**-0.18** 58%	**-0.04** 13%	**-0.32** 100%

Δ INEQUALITY (MLD)	**SUB-SAHARAN AFRICA**	Share of total decline in resource inequality associated with changes in: *Population Size*	- *Age Dependency*	+ *Income*	+ *Allocation*	
0.36		-0.03 *-59%*	-0.16 *-336%*	0.24 *518%*	-0.01 *-23%*	100%

=Component reduced inequality

=Component increased inequality

While we see evidence of global convergence in educational inequality, our results also suggest increasing inequality within sub-Saharan Africa. To investigate the drivers of this change, the lower portion of Table 4.2 displays the decomposition of the .36 gain in regional inequality into the four substantive drivers. The only factor driving the increase in regional inequality was differential changes in income (.24). While some countries soared ahead, others lagged behind and several experienced economic reversals. As a result, educational quality in the region became more differentiated during this period. This is despite the fact that patterns of age dependency, growth population size, and allocation of resources converged.

4.5 Conclusions

Overall, the findings suggest improving educational quality at the global level. However, this average trend masks severe inter and intra regional differences. Between 1990 and 2005, the average school related expenditures in North America grew by $3,652 dollars. The growth in regions like South Asia ($34) and sub-Saharan Africa ($68) pales in comparison. Another way to consider the global variation is that highest *total* per child expenditure in the sub-Saharan region ($1,268 in Botswana) in 2005 is not even half of the average *gain* that was registered in Europe ($4,488) and North America ($3,652). Globally, the largest driver of change in educational quality is change in income, though improvements in age dependency also made large contributions.

While the global average masks severe inter-regional differentiation, we also find evidence of vast intra-regional variation. By 2005, average level of resources per child (r) in Botswana was $1,268, while the number plummets to $2 in the Democratic Republic of Congo. Some countries (i.e. Botswana, South Africa, and Lesotho) experienced substantial gains in educational expenditures per child, while others (i.e the Congo, the Gambia, Cote D'Ivoire) experienced declines. Similar to the global decomposition, changes in the economy tended to be the largest drivers of change, though changes in age dependency also played a critical role.

Beyond the actual expenditures themselves, there is evidence of a convergence in the quality of educational experiences for children globally. This finding is largely due to the improving economic and demographic conditions found in East Asia and the Pacific between 1990 and 2005. At the same time, the findings regarding inequality patterns within sub-Saharan Africa mirror those of Kandiwa (2006), who found that economic trajectories of sub-Saharan nations are increasingly divergent. The increased inequality within the region was exclusively driven by increased differentiation in national economic conditions.

There are some limitations to this study. First, the estimates are of the gains in educational expenditures per child. Conceptually, this is a more ideal place to measure whether or not countries are able to realize a dividend. However, policy interest is still in the last stage of the process- the extent to which gains in expenditures translate into gains in enrollments. Thus future research that evaluates the extent to which gains in expenditures lead to gains in enrollments would be useful. Case studies that identify what polices lead to the more efficient conversion process would also be appropriate here.

In sum, however, the findings point to several interesting conclusions. First, fertility transitions do generate a macro-level schooling bonus, as captured by national educational expenditures per child. Given this fact, future fertility declines in sub-Saharan Africa may play a critical role in improving schooling outcomes in the region. However, findings also suggest that this will only occur if these declines are accompanied by stable economic growth and national commitment to educational expenditures. Indeed, several countries in the region could have realized a dividend from declining fertility, but were hampered by poor economic conditions and reductions in the policy commitment to educational spending.

Second, children may be increasingly growing up global, but with vastly different educational experiences, as shown in Table 4.1. Beyond a global commitment to expanding educational enrollments, these findings call for increased attention to the large differentiation in the quality of educational experiences. At the same time, findings from the inequality analysis suggest a growing global convergence, largely driven by improving conditions in East Asia and the Pacific. In this region, policymakers were able to fully capitalize on improving demographic factors by ensuring stable economic growth and policy commitment to schooling. If sub-Saharan Africa is going to be able to make the most of their dividend, and contribute to future declines in global inequality in schooling, policymakers should take heed of the East Asian experience.

Third, findings suggest increasing differentiation within the sub-Saharan region with regards to educational inequality- a trend largely driven by increased variation in the economic conditions of countries. Given this finding, it's likely that regional policy alone will not be sufficient to meet the MDG goal of achieving universal primary enrollment. Instead, the particular economic and demographic conditions of nations must be evaluated when deciding where to invest limited resources.

CHAPTER 5.
IS THE LINK BETWEEN FERTILITY AND CHILD SCHOOLING CAUSAL?

5.1 Background

The analyses in Chapter 4 use a decomposition approach to estimate the schooling dividends associated with fertility transitions. While this approach allows one to bypass some of the problem associated with cross-country regressions and permits inquiry at the policy-relevant level, it still depends on the use of problematic macro data. Partially because of the problems associated with using such data, the bulk of research in recent decades has flowed from the dilution hypothesis. Using this framework, researchers examine the sibsize-schooling relationship with micro-level data, as they allow for more rigorous and refined estimation of the effect of sibsize on schooling.

Yet, as noted in Chapter 2 and 3, the dilution hypothesis remains a contested proposition within the field of demography. While work by many scholars (Anh et al. 1998; Bhat 2002; Blake 1981, 1989; Downey 1995; Knodel et al. 1990; Knodel & Wongsith 1991; Mare and Chen 1986) has provided support for a negative relationship between sibsize and schooling, numerous other studies have found non-significiant even positive associations (Black, Deveraux & Chernichovsky 1985; Gomes 1984; Lloyd 1994; Montgomery and

Kouame 1993). Some scholars attributed these mixed findings to the fact that the sibsize-schooling relationship is conditioned upon broader socioeconomic conditions (Lloyd 1994, Desai 1995) and several researchers have attempted to address this issue by modeling the historical changes in the association between fertility and schooling using longitudinal data in China (Lu & Treiman 2005), Thailand (Pattaravanich et al. 2005), Malaysia (Sudha 1997) and Cameroon (Eloundou & Williams 2006).

The latter presented an exhaustive test of the dilution hypothesis by using detailed life-history data for several cohorts of children to evaluate how the sibsize-schooling relationship depended on whether or not the researcher: 1) used a time varying measure of sibsize; 2) adjusted for clustering of observations, unobserved characteristics of families, and child ability; 3) accounted for the presence of fosterage and 4) accounted for general historical and economic change. Thus, the first two steps account for potential methodological bias and the latter steps adjust for contextual forces. Overall, the findings generate support for the dilution hypothesis. Whether or not the researcher used a time varying measure of family size or adjusted for potential statistical biases stemming from child's ability, clustering at the family level, or unobserved family characteristics does not substantively change the relationship between sibsize and schooling. Instead, the relationship, following most other findings, appears to be conditioned on broader historical and economic contexts.

While these methodological approaches undoubtedly improve the claim for a causal relationship between sibsize and schooling, the problem of endogenity remains. In 2005 work by Black, Deveraux and Salvanes posited that despite "extensive theoretical literature that postulates a trade-off between child quantity and quality within a family...there is little causal evidence that speaks to this theory" (p. 669). Researchers, especially economists continue to argue that "if there is simultaneity between the decisions on number of siblings and desired educational attainment for those children, then neither additive nor interactive models of school attainment are correct as they assume that sibship size is determined prior to schooling" (Mareleto 2001, p. 13). The gold standard for these researchers has been the use of instruments in modeling the sibsize schooling relationship. However, as noted in the Chapter 3, this approach is plagued with problems: the data is sparse; there is little consensus on which instrument is best; and there are other fundamental modeling problems, which might mask the impact of instruments.

5.2 Research questions

As a means to address the issues, the analysis here proceeds in two steps. The first step uses longitudinal data from Cameroon to estimate the net statistical association between sibsize and schooling after addressing for time varying sibsize, clustering, fixed effects, and historical and economic trends. The second step posits that, if a significant relationship is evident in Step 1, the problem of endogenity could still remain. We could try to improve the estimate using an instrument, but instead approach the problem from a different perspective. Here we use data on cause of dropouts to consider whether or not children from larger families are more likely to drop out of school due to lack of money.

The logic of this second step is discussed further below, but essentially is premised on the idea that, if there is no causal relationship between sibsize and schooling, children with many siblings should not be more likely than those with fewer siblings to drop out for lack of money. A finding, however, that there is a significant relationship between sibsize and dropout due to lack of money would provide further support for the dilution hypothesis and evidence of a causal relationship.

5.3 Data, methods & measures

5.3.1 Data

Data for this analysis came from a 1999 survey from Cameron and are described in detail in Chapter 4. To model the impact of sibsize on school dropout, I use the longitudinal schooling sub-sample, containing 52,909 person years from 11,590 children. To model the impact of sibsize on school dropout due to money, I restrict the analysis to all children who dropout due to lack of money (N=2123).

5.3.2 Methods

The analysis proceeded in two steps. First, I conduct a logistic regression using the GEE estimation procedure in SAS:

$$\ln(p_{igt}/1 - p_{igt}) = \beta_0 + \beta_1 F_{it} + \beta_2 H_{it} + \beta_3 C_{it} + \beta_4 X_{it}$$

where a child's logit of school dropout at a given grade g and historical time t (p_{igt}) as a function their family size in that given year(F_{it}), individual human capital skills(Hit), historical and economic context (C_{it}), and their individual and household socio-demographic characteristics (X_{it}).

If there is evidence of a negative relationship between sibsize and schooling, I then have reason to proceed to the next stage of the analysis. While initial regression adjusts for multiple factors (clustering, fixed effects, time-varying sibsize, individual ability of the child, and economic and historical context) and helps refine the estimate of the relationship, it does not fully address the problem of endogeneity- parents could still be choosing to simultaneously invest in quality and quantity. Instead of taking the prevailing approach of using an instrument, the next step is to reduce the sample to those students that reported a dropout, and then use a standard logistic regression to model all dropouts and estimate the impact of sibsize on dropout due to lack of money (as opposed to all other factors):

$$\ln(pSES_{igt}/1 - pSES_{igt}) = \beta_0 + \beta_1 F_{it} + \beta_2 H_{it} + \beta_3 C_{it} + \beta_4 X_{it}$$

where, given that a child experiences a dropout, a child's logit of school dropout due to lack of money at a given grade g and historical time t (p_{igt}) as a function their family size in that given year(F_{it}), individual human capital skills(Hit), historical and economic context (C_{it}), and their individual and household socio-demographic characteristics (X_{it}).

This approach is based on the argument that, if there is no causal link between sibsize and schooling, there should be no relationship between sibsize and dropout due to lack of money. If parents make a joint decision to invest in both child quality and quantity, then parents with few children and those with many will be equally likely to report that their child dropped out due to lack of money. However, evidence of a significant relationship between sibsize and dropout due to lack of money would provide strong support for the dilution hypothesis. Evidence of such relationship would suggest that parents with a large number of children face a greater challenge in mustering the financial resources needed for their children to stay in school.

5.3.3 Measures

The dependent variable in the first step of the analysis is dropout, measured dichotomously by annual enrollment status during the index year. The categories for this variable were coded 1 for years during which a child experiences a terminal school exit (whether dropout or graduation), given that s/he enrolled in school at the beginning of the school year. Years of continued enrollment are coded 0. For the second stage of the analysis, the data set is restricted to individuals who have dropped out of school, and the dependent variables is dropout due to lack of money. This variable was coded 1 if the parent reported the child had to drop out of school due to lack of money, and 0 for all other dropout reasons (including poor grades, pregnancy, marriage, job opportunity, poor health, death and other).

The main independent variable in both the primary and secondary analyses is sibsize. This variable is a time varying measure for both of the analyses and thus represents the number of living siblings at time of dropout. Other independent variables in the analysis include a set of human capital variables: child repeats current grade, child repeats more than one grade, and inordinate ability. The latter variable reflects the unlikelihood that a child with a specified socio-demographic profile (constructed based on sex, family SES, family size, family structure) will still be enrolled in school. Specifically, schooling life tables were used to estimate the school survivorship chances of children with various socio-demographic profiles. The child's inordinate ability is then inferred by comparison with the expected school survivorship for an average child with his/her socio-demographic characteristics. A child who remains in school at a grade where the probability (p) of school survivorship in his/her reference group is very low will therefore be considered unusually driven or able. The value 1-p is used as a simple indicator of unusual ability. It varies between 0 and nearly 1, with higher numbers representing greater ability.

In addition to the human capital controls, both models control for contextual effects, accounting for historical trends (years since 1955/10) and economic conditions (log GNP per capita). They also include basic compositional controls (sex, age, birth order, fosterage status, family SES, presence of single mother, presence of sibling in the workforce and grade level).

5.4 Findings

5.4.1 Sibsize and school dropout

Results from the first step in the analysis are presented in Table 5.1. Overall, findings show a positive association between sibsize and schooling, even after accounting for time-varying sibsize, child's human capital, clustering, fixed effects, and historical and economic trends. Each additional sibling raises the likelihood of dropout 1.12. Given that the average TFR during the study period ranges from 5-7, sibsize becomes a critical factor in shaping the likelihood of dropout.

The controls in Table 5.1 operate in the expected fashion- children who repeat one (O.R.=1.27) or more grades (O.R.=1.27) are most likely to drop out of school, though the selection variable does not have a significant effect. There is no evidence of a significant historical trend, though children are more likely to dropout during periods of good economic conditions (O.R.=1.21). Girls (O.R.=1.77) and older children (O.R.=1.15) are more likely to drop out of school, while those higher in the birth order (O.R.=.90) and those who are fostered out (O.R.=1.71) are less likely to drop out. The fact that fostered children are less likely to drop out is likely due to a selection process in the decision about which children will be fostered.

Table 5.1. Event History Analysis of the Effect of Family Size on School Dropout

	Est.		Hazard Ratio
DILUTION EFFECT			
Time varying sibsize	0.12	***	1.12
HUMAN CAPITAL EFFECT			
Child repeats current grade	1.27	***	3.58
Child repeats for more than one grade	1.27	***	3.57
Inordinate ability	0.42		1.52
CONTEXTUAL EFFECT			
Historical trend (Years since 1955/10)	-0.11		0.90
Log GNP per capita	0.19	*	1.21
COMPOSTIONAL VARIABLES & BASIC CONTROLS			
Child is female	0.57	***	1.77
Child's age	0.14	***	1.15
Rank in birth order	-0.11	*	0.90
Child is currently fostered out	-0.34	**	0.71
Family has high SES	-0.02		0.98
Mother is single	-0.92		0.40
Child has at least one sibling working	-0.17		0.84
grade2	1.39	***	4.00
grade3	1.77	***	5.89
grade4	2.45	***	11.55
grade5	2.77	***	15.98
grade6	4.42	***	82.68
grade7	3.90	***	49.45
grade8	4.20	***	66.89
grade9	3.96	***	52.63
grade10	4.56	***	95.59
grade11	4.12	***	61.74
grade12	4.01	***	55.29
grade13	4.15	***	63.33
grade14	3.58	***	35.82
grade15	4.16	***	64.24
grade16	5.40	***	220.47
grade17	5.08	***	161.36

*p < = .05, **p < = .01, ***p < = .001

5.4.2 Sibsize and school dropout due to lack of money

While the estimate of sib-size on school dropout uses a range of methods to improve the quality of the estimate, it does not fully address the problem of endogenity. The next step reduces the sample to all children who report a dropout and models the likelihood of dropping out due to lack of money, as opposed to all other factors.

Figure 5.1 Parental Reports about the Main Cause of Dropout, Cameroon, 1959-1999

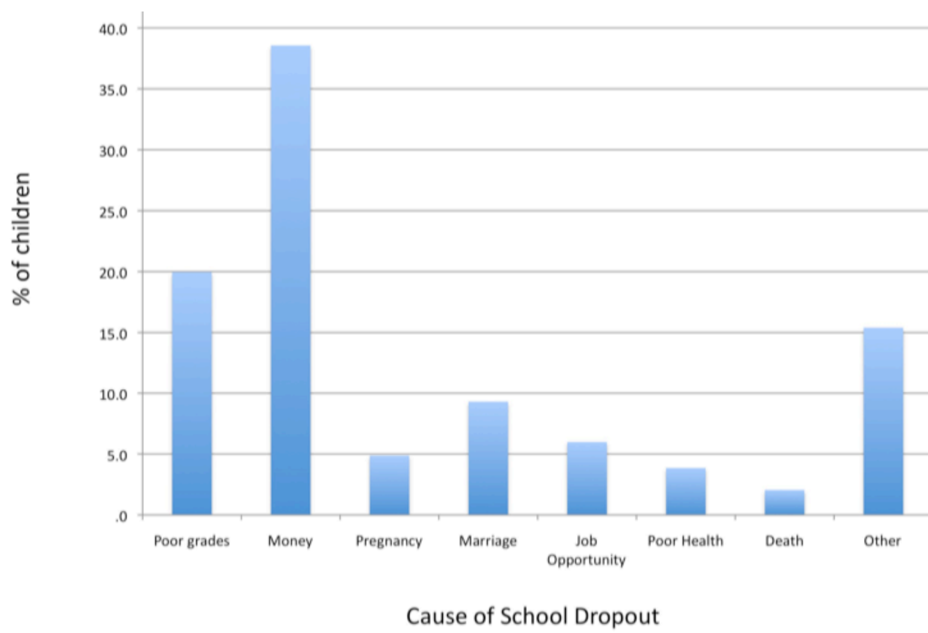


Figure 5.1 shows the percentage of school dropout by cause. Lack of money is the predominant cause of dropout in Cameroon- of the 2,054 children in the sample, nearly 40% report dropping out due to a lack of money. Given the large number of children who report dropping out due to lack of money, the next step in the analysis is to determine if there is a positive association between sibsize and dropout due to lack of money.

Findings in Table 5.2 show the results of a logistic regression of sibsize on school dropout due to lack of money. The most striking finding here is that each additional sibling

Table 5.2 Logistic Regression of Family Size on Dropout due to Lack of Money

	Est.		Hazard Ratio
DILUTION EFFECT			
Time varying sibsize	0.06	*	1.06
HUMAN CAPITAL EFFECT			
Child repeats current grade	-0.12		0.89
Child repeats for more than one grade	-0.35	*	0.70
Inordinate ability	1.13	*	3.10
CONTEXTUAL EFFECT			
Historical trend (Years since 1955/10)	-0.87		0.42
Log GNP per capita	-0.14		0.87
COMPOSTIONAL VARIABLES & BASIC CONTROLS			
Child is female	-0.55	***	0.58
Child's age	-0.05	*	0.96
Rank in birth order	0.01		1.01
Child is currently fostered out	0.26	+	1.30
Family has high SES	-0.03		0.97
Mother is single	0.48		1.61
Child has at least one sibling working	-0.10		0.90
Child's Grade in School	-0.10	*	0.90
Constant	2.86		17.54

*p < = .05, **p < = .01, ***p < = .001

increases the hazard that a child will drop out due to lack of money 6 percent. Conceptually, this is quite compelling, especially given the large average sibsize of the population. Again, while it does not improve the estimate of sibsize on schooling, this finding does provide additional support for a causal relationship.

With regards to the rest of the controls, Table 5.2 also shows that children who repeat grades are less likely to drop out due to lack of money (O.R.=.70) while those who have high inordinate ability are more likely to report dropping out due to lack of money (O.R.=3.10). This finding is also compelling, as it suggests that individual characteristics of children play a key role in whether or not they dropout due to lack of resources. Proponents of the endogenity argument would contend that individual ability doesn't really matter-parents make a decision about quality and quantity and "stick to it". These findings suggest that, if a child is truly skilled, they are more likely to drop out due to lack of resources. Frequent repeaters are less likely to drop out due to lack of money. These findings are somewhat counterintuitive but make more sense when considering the total population. Frequent repeaters are more likely to drop out due to poor grades, while those who have high ability and are forced to dropout are unlikely to report dropping out because of poor grades.

Girls are less likely to dropout due to lack of money (O.R.=0.58), as opposed to other factors. This also may seem strange, but not once we consider that *only* girls can dropout due to pregnancy, which is included among the reasons for dropout. Older children (O.R.=0.96) and those at higher grade levels (O.R.=0.90) are less likely to report dropping out due to a lack of money, while children who are fostered are more likely to report dropping out due to lack of money (O.R.=1.30).

5.5 Conclusions

The evidence here clearly supports the dilution hypothesis. Even after adjusting for a range of methodological biases and contextual forces, children with a large number of siblings are more likely to dropout of school than children who have fewer siblings. Given a lack of instruments in the data, and the lack of consensus regarding the choice and use of instruments themselves, I chose to explore the causal nature of the sibsize-schooling relationship in a new way. Findings from the second regression show that children from larger families are more likely to report a drop out due to a lack of money. Although these children would like to continue their schooling, their large number of siblings is *diluting* family resources to the extent that schooling costs become unbearable.

One clear limitation to these findings is that it does not provide a more precise estimate of the sibsize-schooling relationship, as an instrument would. However, it serves, with other existing evidence, as a new way to triangulate the nature of the sibsize schooling relationship. Another limitation is that the limited geographic scope of the findings. Future analyses will use DHS data to examine the relationship between sibsize and cause of dropout to determine the generalizability of this finding.

Overall, evidence of a causal relationship is important. It suggests that efforts to reduce family size can have real, causal implications for children's schooling. Thus, at the family level, policies that encourage fertility decline can also be expected to have important spillover effects in terms of boosting educational attainment. However, as noted in Chapter 2, evidence of a causal link at the individual level does not provide a full accounting of how household level declines in sibsize translate into national level gains in schooling enrollments. An aggregation and decomposition method that integrates micro and macro level data is examined next, in Chapter 6.

CHAPTER 6:
PROGRESS IN THE EDUCATION MDGS:
THE RELATIVE ROLE OF DEMOGRAPHIC AND ECONOMIC CHANGE

6.1 Background

As countries progress through their demographic transitions, improvements in dependency should result in a demographic dividend. As noted in Chapter 4, many studies have examined the dividend in terms of macroeconomic gains, but fewer have considered the relevance of these transitions for schooling. Moreover, many have simply used macro-level data to conduct standard cross-country regression to estimate the impact of the change in the age structure with various socioeconomic outcomes. While the previous analyses in Chapter 4 used a decomposition approach to bypass some of the problems associated with cross- country regressions, the analyses still depend on macro level data. This next set of analyses takes a different approach- it uses findings from micro-level data and, following the logic of Knodel et al, and others described in Chapter 2, aggregates them in a way that allows one to fully assess the national level impact of fertility transitions.

The focus in these analyses is squarely on sub-Saharan Africa. The United Nations' commitment to expand access to schooling under the aegis of the Millennium Development Project presents a particularly formidable challenge for many African countries (UN 2010). Given the disparity between Saharan Africa's large school-age population and budgetary allocations for education that on average amount to no more than 4–5% of Africa's gross domestic product (GDP), levels of expenditure per student are very small and make resource allocation a critical challenge for post-colonial states. These targets set for 2015 will likely be missed by many countries unless progress is accelerated, and this in turn depends on new infusion of budget resources, increased efficiency, or the kind of opportunistic boost that a demographic dividend could provide (Bloom, Canning and Sevilla 2003; Sahn & Stifel, 2003; Ross 2004). Future gains in educational attainment will also reflect improvements in the resources individual families are able to expend on schooling for children. This, in turn, depends on both fertility patterns, in so far as they impact the number children living in high-SES household, and also the extent to which SES impacts attainment.

6.2 Research questions.

This paper seeks to understand the socio-demographic drivers of recent trends in schooling attainment in sub-Saharan Africa. The analyses focus on the years 1991-2008, a time of rapid socio-demographic change in the region, and it covers 19 sub-Saharan countries that have experienced a wide variety of economic and demographic changes during this period. To investigate this issue, I integrate regression findings into a series of decomposition methods. This decomposition makes it possible to estimate the complementary contributions of demographic transitions, changes in the distribution of children across various SES groups, and broad-based national policy. More concretely, this expanded decomposition evaluates how much individual countries' inter-survey changes in educational attainment is dependent on change in:

(1) baseline educational opportunities?

(2) the education gradient associated with SES?

(3) the relative fertility change associated with each SES group ?

(4) the proportion of families in various SES groups?

6.3 Data and methods

6.3.1 Data

Data for this study comes the Demographic Health Surveys, and covers 17 countries over a period from 1991 to 2008[12]. One country (Kenya) provides four survey years, eleven countries (Burkina Faso, Cameroon, Madagascar, Mali, Malawi, Namibia, Rwanda, Zimbabwe) provide three survey years, and five countries are surveyed twice (Benin, Ethiopia, Ghana Guinea, Mozambique, Niger, Nigeria, Tanzania). Figure 6.1 shoes the geographic distribution of countries.

[12] While more surveys exist during this time period, missing data prohibited their analysis.

Figure 6.1 Sub-Saharan Study Countries, 1990-2005

6.3.2 Methods

To investigate the drivers of change in educational attainment, I first use standard OLS regression to estimate the effect of socioeconomic status (an index based on household durables and coded 1 to 5, with 5 indicating the highest status group) on attainment levels among children aged 10-21 for each country-year file.

I then use the resulting parameters *a, ß* and *μ* generated from the grouped regression, as well as data from the changes in the various SES group-specific fertility ratios (r) and group-specific size (n) for mother's aged 15-49 to apportion the change in national enrollment levels that are observe between successive survey years into the effects of changes in:

(1) the baseline educational opportunities that affect all socioeconomic groups ($\Delta\alpha$); (2) the change in the education gradient associated with SES ($\Delta\beta$);
(3) the relative fertility change of mothers in each socioeconomic group (Δm_i);
(4) the proportion of families residing in each SES groups (w_i).

To evaluate the relative importance of each component, the decomposition proceeds in three distinct steps:

$$\text{(1a)} \quad E = \sum \boldsymbol{w_i} * \boldsymbol{e_i}$$

$$\text{(1b)} \quad \Delta E = \underbrace{\sum \bar{w}_i \, \Delta e_i}_{\boxed{\text{A}}} + \underbrace{\sum \bar{e}_i \Delta w_i}_{\boxed{\text{B}}}$$

where w_i represents the percentage of children within socioeconomic group i and e_i represents the group specific enrollment for each socioeconomic group.

As shown in formula 1a levels of national educational attainment are a function of the percentage of children in each socioeconomic group multiplied by that group specific average educational attainment. The first decomposition (1b) apportions changes in educational attainments into two terms: (A) those due to changes in group-specific levels of educational attainment and (B) those due to a change in the distribution of children across socioeconomic status groups.

However, these components can each be further broken down. The first term, changes in group-specific educational attainment levels, can be decomposed into three separate components:

$$(2)\quad \Delta E = \underbrace{\sum \bar{w}_i\, \Delta\alpha}_{\text{A1}} + \underbrace{\sum \bar{w}_i\, \Delta\beta * SES_i}_{\text{A2}} + \underbrace{\sum \bar{w}_i\, \Delta\mu}_{\text{A3}} + \underbrace{\sum \bar{e}_i \Delta w_i}_{\text{B}}$$

where w_i represents the percentage of children within socioeconomic group i and e_i represents the group specific educational attainment for each socioeconomic group. The alpha (α), beta (ß) and residual (μ) terms are all generated from the grouped regression of socio-economic status on educational attainment.

This decomposition thus apportions changes in group-specific educational attainment into those due to changes in baseline educational opportunities (A1), changes in the effect of income (A2), and changes in all other effects outside of socioeconomic status (A3). As is clear in the formula, the composition component (B) remains the same.

While this first decomposition provides insight into the changing relevance of family SES (A2) as opposed to other factors (A1, A3) we are also interested in understanding how changes in levels of fertility by class might also contribute to changes in educational attainment. To address this issue, we can decompose the composition component (B) into two terms:

$$(3)\quad \Delta E = \underbrace{\sum \bar{w}_i\, \Delta\alpha}_{\text{A1}} + \underbrace{\sum \bar{w}_i\, \Delta\beta * SES_i}_{\text{A2}} + \underbrace{\sum \bar{w}_i\, \Delta\mu}_{\text{A3}} + \underbrace{\sum \bar{e}_i \bar{n}_i * \Delta r}_{\text{B1}} + \underbrace{\sum \bar{e}_i \bar{r}_i * \Delta n}_{\text{B2}}$$

where w_i represents the percentage of children within socioeconomic group i and e_i represents the group specific educational attainment for each socioeconomic group. The alpha (α), beta (ß) and residual (μ) terms are all generated from the grouped regression of socio-economic status on educational attainment. The n_i term represents the proportion of mothers in socio-economic status group i and the r_i term represents the relative fertility of socioeconomic group i.

Here the rationale is that the change in the distribution of children across socioeconomic status groups stems from two factors—the relative fertility of mothers in each socioeconomic group (B1) and the proportion of mothers in each socio-economic status group (B2). This decomposition allows an assessment of the relative role of socioeconomic and demographic factors.

6.4 Findings

6.4.1 Changes in educational attainment

Findings are presented in Table 6.1. Results show that the average educational attainment among children aged 10-21 was 1.14 during this period, which is somewhere between incomplete (coded 1) and complete (coded 2) primary school. However, the region shows vast differentiation between countries and over time. Mali (96), Burkina Faso (99) and Niger (98) all registered mean education levels below .5, while Ghana (08), Namibia (07) and Zimbabwe (99, 06) achieved education levels greater than 1.75.

The results also show evidence of both educational gains and reversals. Seven countries experienced reversals, with values ranging from -.14 in Zimbabwe between 1999 and 2006 to -.02 in Cameroon between 1991 and 1998. These findings correspond to other studies that have noted education reversals during this time period (Derose & Kravdal 2007). Interestingly, nearly all countries that experienced declines also registered gains in for another period. Moreover, it's important to note here that countries experiencing a decline had an average educational level of 1.3, compared to 1.1 for countries that experienced gains. Thus, the countries that gained started from a lower platform with more room for upward growth. Overall, the largest educational gains were seen in Nigeria (1990-2003), Ghana (1993-1998) and Zimbabwe (1994-1999).

Table 6.1. Africa's Progress in the Education MDGs: Decomposition Findings

					Decomposition 1		Decomposition 2				
Country	Time Period	Edu. Time 1	Edu. Time 2	Change T1-T2	A	B	A1	A2	A3	B1	B2
EDUCATION REVERSALS											
ZIMBABWE	1999-2006	2.02	1.89	-0.14	78%	22%	24%	53%	1%	19%	3%
BURKINA FASO	1993-1999	0.53	0.43	-0.10	81%	19%	-19%	98%	1%	6%	13%
KENYA	1993-1998	1.36	1.32	-0.05	89%	11%	390%	-297%	-5%	20%	-9%
KENYA	1998-2003	1.32	1.27	-0.05	110%	-10%	697%	-588%	2%	-20%	9%
RWANDA	2000-2005	1.08	1.05	-0.04	37%	63%	-259%	308%	-11%	37%	26%
CAMEROON	1991-1998	1.41	1.39	-0.02	-271%	371%	7%	-286%	9%	181%	189%
EDUCATION GAINS											
NIGERIA	2003-2008	1.65	1.69	0.03	229%	-129%	-736%	946%	19%	-145%	16%
MALAWI	2000-2004	1.15	1.19	0.05	117%	-17%	-153%	276%	-6%	-21%	5%
TANZANIA	1999-2005	1.09	1.15	0.07	102%	-2%	-196%	293%	5%	1%	-3%
RWANDA	1992-2000	1.01	1.08	0.07	69%	31%	-15%	85%	-1%	34%	-3%
NIGER	1998-2006	0.46	0.55	0.09	59%	41%	66%	-6%	0%	27%	13%
MOZAMBIQUE	1997-2003	0.82	0.95	0.13	120%	-20%	40%	78%	2%	-22%	2%
MADAGASCAR	2004-2009	1.17	1.31	0.13	97%	3%	93%	8%	-4%	1%	2%
BURKINA FASO	1999-2003	0.43	0.57	0.14	102%	-2%	58%	44%	0%	-5%	3%
CAMEROON	1998-2004	1.39	1.53	0.14	104%	-4%	105%	-4%	3%	-5%	2%
MADAGASCAR	1997-2004	1.02	1.17	0.15	96%	4%	12%	80%	4%	1%	4%
MALI	1996-2001	0.36	0.52	0.15	59%	41%	55%	5%	-2%	-4%	44%
KENYA	2003-2009	1.27	1.45	0.18	99%	1%	87%	13%	-1%	1%	0%
NAMIBIA	1992-2000	1.39	1.58	0.19	107%	-7%	13%	95%	-1%	-7%	1%
GUINEA	1999-2005	0.57	0.78	0.21	104%	-4%	49%	56%	-1%	-2%	-3%
MALI	2001-2006	0.52	0.73	0.22	103%	-3%	88%	15%	-1%	-4%	1%
GHANA	2003-2008	1.57	1.79	0.22	109%	-9%	141%	-32%	1%	-15%	5%
BENIN	1996-2001	0.64	0.87	0.23	96%	4%	60%	37%	-1%	2%	2%
NAMIBIA	2000-2007	1.58	1.82	0.24	99%	1%	98%	0%	1%	1%	0%
MALAWI	1992-2000	0.91	1.15	0.24	103%	-3%	125%	-22%	0%	-4%	1%
ETHIOPIA	2000-2005	0.58	0.82	0.24	103%	-3%	77%	24%	2%	-7%	4%
ZIMBABWE	1994-1999	1.76	2.02	0.26	93%	7%	7%	87%	-1%	7%	0%
NIGERIA	1990-2003	1.34	1.65	0.31	95%	5%	49%	47%	-1%	-14%	19%

Notes: Data Source: Demographic Health Surveys. Results not reported for Tanzania 1996-1999 due to lack of change in national education levels.

6.4.2 Decomposition of changes in educational attainment

The first decomposition (Decomposition 1) in Table 6.1 apportions changes in attainment into two terms: (A) those due to changes in group-specific attainment rates and (B) those due to a change in the distribution of children across socioeconomic status groups. Whether considering educational gains or reversals, change in group-specific attainment rates (A) is the predominant driver.

In countries experiencing education reversals, the first decomposition shows that shifts towards more disadvantageous group specific attainment rates (A) was the primary culprit in all cases except for Cameroon 1991-1998 and Rwanda 200-2005. In the former case, national educational attainment levels declined despite improving attainment rates among groups (-271%) and the decline can instead be attributed to more children moving into lower SES groups (371%). This finding makes sense in light of the marked economic crises that occurred during the mid-1990s (Eloundou-Enyegue and Stokes 2000). Similarly, crisis in Rwanda between 2000-2005 led to both declines in group-specific attainment rates (37%), but more importantly, more children residing in lower SES households (63%).

Among countries with education reversals driven primarily by improvements in group specific attainment rates (A), the effect of compositional shifts (B) is still important, accounting for anywhere from -10 to 22% of change. Overall, the compositional component tends to have a positive effect, indicating that compositional shifts characterized by children moving into less advantageous SES groups. Conversely, in Kenya (1998-2003) an increasing number of children residing in higher SES households acted to boosted attainment (110%) but not enough to counteract the declines in group-specific educational attainment levels (-10%).

Turning to countries that experienced education gains, it's clear that changes in group-specific attainment levels vastly outweigh the importance of compositional shifts. While the compositional term accounts for at least 10% of change in all countries experiencing attainment declines, it only accounts for such change in one-third of the countries experiencing attainment gains. Improvements in group-specific attainment rates are evident in all cases. Interestingly, though at times small, the compositional component contributed negatively in about half of cases and positively in the other half. Thus in

Mozambique, which registered a .13 unit gain in educational attainment would have been higher if not for the movement of more children to low SES households (-20%). Conversely in Niger, the movement of more children to high SES households accounted for 41% of the .09 unit gain in attainment.

The second decomposition apportions changes in group-specific educational attainment levels (A) into change due to: shifts in baseline educational opportunities, or changes in the educational context that impact all children equally (A1), changes in the effect of socioeconomic status (A2), and changes in all other effects outside of socioeconomic status (A3). It also apportions change in the distribution of children across socioeconomic status groups (B) into change due to: the relative fertility of mothers in each socioeconomic group (B1) and the proportion of mothers in each socio-economic status group (B2).

In cases of education declines and reversals, the A1 and A2 terms drive the predominance of change. In cases where we see education gains, general expansion of educational opportunities (A1) and a decline in the effects of socioeconomic status (A2) boost gains in 80% of the cases. In countries where education declined, the direction of the effect of A1 and A2 are more mixed.

For example, the largest attainment decline (-.14) in the sample occurred in Zimbabwe (1999-2006) and was mostly driven by declining among all SES groups (A1=24%) and increases in the effect of SES (53%). These findings make sense given the severe economic crises that occurred during this time period. At the same time, we find that relatively higher fertility among mothers of low SES children (B1=19%) also played a key role in shaping the educational downturn. Conversely, the .05 decline in Kenya (1998 to 2003) was driven almost entirely by a general decline in baseline education opportunities (A1=697%), even though the effect of SES was diminishing during this time period (A2=-297%). I additionally find that declining fertility among mothers in low SES groups worked to break the decline in educational attainment (B1=-20%).

Nigeria experienced the largest education gains (.31) and these were predominantly driven by increasing attainment among all SES groups (A1=49%) and declines in the effect of SES (47%). A declining proportion of mothers residing in low SES households (B2=19%) additionally boosted gains, but the relatively high fertility of low SES women worked to counteract gains (B1=-14%). While the economic terms (A1 & A2) were the dominant driver of change, the findings suggest that population components matter as well. In 60 percent of cases, gains would have been larger if not for the relatively higher fertility of low SES mothers (B1). Evidence also suggests that a decline in the number of women living in low SES households (B2) generally contributed to boosting educational attainment levels, though the impact was relatively small.

5.5 Conclusions

This chapter has both substantive and conceptual implications. On the substantive side, I find that changes in levels of schooling attainment in sub-Saharan Africa will depend not only on socioeconomic conditions, but on changes in demographic factors as well. Most of the countries in this study experienced gains in enrollment., but about 25% of countries experienced education reversals, a finding similarly noted in other studies (DeRose & Kravdal 2007). Results from the first decomposition reveal that behavioral change (increased educational attainment across socioeconomic groups) accounted for the lion's share of change in educational attainment. However, compositional shifts in the population contributed to more than 10% of changes in educational attainment in 12 of the 28 time periods. The second decomposition further reveals significant variation in drivers of the behavioral component itself. In some countries, change was driven largely by changes in baseline educational opportunities while in other countries changes in the relative importance of SES was more critical. Within the compositional component, the predominant driver was the changing fertility patterns of each SES group, as opposed to the number of mothers in each SES group.

This analysis helps understand the sources of change in educational attainment. However, given that findings suggest large variation in the drivers, a useful next step would be to use a multi-level modeling approach to consider how macro level policy factors (i.e. percentage of GNI spent on schooling, per capita spending on family planning services, colonial history) shape the magnitude of the drivers themselves. For example, work by Lloyd and Hewett (2009) finds that differential investments by former colonial rulers continue to shape intra-regional inequality in educational attainment. Citizens living under

British rule were more likely to have access to basic education than individuals who lived in countries controlled by French, Portuguese and Belgian powers, who tended to invest only in the education of the small national elite needed to serve in administrative posts.

Conceptually, this analysis proposes a unique methodological approach to aggregate micro-level data in a manner that allows for a fuller assessment of the national level impact of fertility transitions, and how this impact compares to the effect of more general socioeconomic change. This approach is useful in that it allows one to generate refined group-specific micro-level estimates of almost any social change of interest (infant mortality, obesity, marriage etc.), and merge them with information on the distribution and differential fertility patterns of specific sub-groups. This approach thus capitalizes on the many efforts by researchers to improve micro-level estimates, but translates these improvements into a framework that has policy relevance.

CHAPTER 7.
CONCLUSIONS AND FUTURE DIRECTIONS

High fertility levels represent a clear development challenge for the African continent. Governments in the region, already strapped for resources, will be called upon to help create the social and economic infrastructure necessary to support the one billion people who will live on the continent by 2050 Yet, while growth remains a challenge, declining fertility levels present a unique opportunity. As the dilution theory posits, declines in the number of children in each household are associated with gains in schooling enrollments. Moreover, although the substantiation of dilution theory is still held to very stringent data and methodological standards, "most scholars have discounted the claim that the link between sibship size and all forms of educational outcomes are completely artifactual" (Steelman et al. 2002, p. 254). In study after study, across a range of geographic locales, researchers have found that declines in family size are associated with important improvements in children's schooling. At the same time, several limitations still cloud our understanding of the national level implications of fertility change for schooling.

This dissertation sought to address these limitations in three distinct steps. First, it moved the focus of inquiry away from the individual (micro) level to a focus on national dividends. The use of micro-level data traditionally allows for more rigorous analysis, but cannot always adequately inform the national (macro) level concerns of policy makers.

Instead of an exclusive focus on the dilution argument, I propose that increased attention should be paid to the dividend hypothesis. Under this framework, improvements in age dependency can lead to increased investments in children. Chapter 2 included a conceptual discussion of the generation of the dividend and its' relation to dilution theory. In Chapter 4, I used data from the World Bank to show that changes in age structure play an important, if not dominant role, in shaping both the magnitude and inequality in educational expenditures per child. Evidence here indicates vast differentiation in the educational experience of children across world regions, and even within sub-Saharan Africa. Global declines in inequality are largely driven by changes in East Asia and the Pacific. Not surprisingly, the population decline and improving age structure of the region is playing a critical role in reducing global inequality. Within sub-Saharan Africa, inequality has grown, even as an improving age dependency played a critical role in buffering further growth in inequality.

As a second step, I addressed the endogenity issue that continues to be a confounding factor in research on the dilution hypothesis. In Chapter 2, I present a conceptual overview documenting why the notion of an endogenous decision regarding child quality and quantity cannot be taken for granted in much of sub-Saharan Africa. In Chapter 3, I provided a discussion of the various methodological approaches used to tackle this issue, with a special focus on the use of instrumental variables. Here I contend that, while they do provide some insights, there is still limited consensus regarding the use of instruments in the sibsize-schooling literature. Thus in Chapter 5, I take a different approach to examining the issue of causality. Here I use event-history data from Cameroon to model the relationship between sibsize and school dropout. Using a range of controls and a host of methodological techniques to estimate the relationship between sibsize and school dropout, I find a statistically significant, and sizable, negative relationship between schooling and sibsize. However, this analysis still does not fully restrict the possibility of an endogenous relationship between sibsize and schooling. Instead of using an instrument, I instead model the effect of sibsize on school dropout due to lack of money and find that children from large families are more likely to dropout of school because they don't have enough money. To put it differently, increases in sibsize dilute the resources available to children from large houses and makes them more prone to money-induced dropout. In sum, findings from both regressions support the dilution hypothesis.

As a final step, this dissertation proposed an aggregation and decomposition framework whereby one could use micro-level estimates to generate macro-level findings. As discussed in Chapter 2, micro-level estimates must be combined with information about changes in the dilution environment and the distributional aspects of fertility transitions in order to adequately assess the macro-level transition gains. Chapter 5 presented an analysis using DHS data from sub-Saharan Africa that combined estimates from micro-level regressions of socioeconomic status on educational attainment with a decomposition framework that allowed for an assessment of the relative importance of changes in economic versus demographic forces. Here we still find evidence that, again while less important than the economic drivers, demographic forces shape gains (and losses) in educational attainment.

With regards to policy, these findings all point to the central role that fertility transitions *can* play in facilitating national gains in schooling. These prospective benefits are of particular interest in sub-Saharan Africa, where enrollments are low, fertility transitions are beginning, and countries are striving to reach the Millenium Development Goals. However, the extent to which fertility transitions *will* translate into national schooling dividends depends on other factors as well. First, future declines in fertility in the region are far from given (Bongaarts 2006; Bongaarts 2008; Shapiro & Gebreselassie 2008). Second, national gains in schooling enrollments will also depend on the expansion of educational opportunities (via policy commitment to education budgets) and continued high returns to schooling (via low rates of unemployment). However, the fact that fertility transitions can have spillover effects is encouraging and policy makers should take heed of the potential schooling gains associated with fertility transitions.

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Appendix Table 4.1. Global Trends & Sources of Change in Educational Resources per Child, 1990-2005

	1990 g	2005 g	1990 k	2005 k	1990 p	2005 p	1990 r	2005 r	Δ r	Age dependency	Income	Social Commitment
Australia	25925	47317	0.05	0.05	0.33	0.29	$3,876	$7,802	$3,926	**17.7%**	**85.1%**	**-2.9%**
Brunei Darussalam	21805	37530	0.02	0.04	0.55	0.43	$912	$3,216	$2,305	**23.5%**	**41.1%**	**35.4%**
China	477	2447	0.02	0.02	0.43	0.31	$20	$141	$121	**22.8%**	**76.7%**	**0.5%**
Fiji	3019	5787	0.05	0.06	0.64	0.52	$215	$668	$453	**20.4%**	**55.0%**	**24.6%**
Hong Kong, China	18717	35598	0.03	0.03	0.31	0.20	$1,735	$6,206	$4,471	**41.2%**	**44.9%**	**13.9%**
Indonesia	1015	1866	0.01	0.01	0.59	0.43	$11	$50	$39	**25.7%**	**37.3%**	**37.0%**
Japan	35125	55012	0.04	0.03	0.26	0.21	$5,456	$8,396	$2,940	**57.1%**	**104.5%**	**-61.6%**
Korea, Rep.	8861	24478	0.03	0.04	0.37	0.27	$740	$3,545	$2,805	**26.2%**	**59.0%**	**14.8%**
Malaysia	3951	7979	0.04	0.06	0.63	0.49	$263	$902	$640	**24.7%**	**53.6%**	**21.7%**
Mongolia	1626	1308	0.13	0.05	0.77	0.43	$273	$138	-$135	**-80.0%**	**29.9%**	**150.0%**
New Zealand	18666	36679	0.06	0.07	0.35	0.32	$3,328	$7,895	$4,567	**9.8%**	**77.1%**	**13.1%**
Philippines	1259	2065	0.02	0.02	0.73	0.59	$39	$77	$38	**33.2%**	**71.1%**	**-4.3%**
Samoa	1844	4234	0.04	0.04	0.74	0.76	$98	$222	$124	**-3.0%**	**102.1%**	**0.9%**
Singapore	17029	37574	0.03	0.03	0.29	0.27	$1,521	$3,727	$2,206	**9.5%**	**87.4%**	**3.1%**
Thailand	2275	3637	0.03	0.05	0.46	0.33	$149	$532	$383	**30.7%**	**34.7%**	**34.6%**
Tonga	2194	3655	0.04	0.04	0.70	0.66	$136	$207	$71	**12.8%**	**122.4%**	**-35.3%**
Vanuatu	2073	2818	0.04	0.06	0.84	0.71	$108	$237	$129	**22.8%**	**38.4%**	**38.8%**
***East Asia & Pacific*[1]**	***9757***	***18234***	***0.04***	***0.04***	***0.53***	***0.42***	***$1,110***	***$2,586***	***$1,475***	***28.4%***	***71.4%***	***0.2%***
Austria	31436	54085	0.05	0.05	0.26	0.24	$6,051	$12,157	$6,105	**13.9%**	**76.9%**	**9.2%**
Belarus	2572	4425	0.04	0.06	0.35	0.22	$303	$1,102	$800	**39.9%**	**37.7%**	**22.4%**
Belgium	30314	54862	0.05	0.06	0.27	0.26	$5,548	$12,342	$6,794	**4.9%**	**73.5%**	**21.6%**
Bulgaria	3290	5099	0.05	0.04	0.31	0.20	$563	$1,055	$492	**73.3%**	**65.7%**	**-39.0%**
Cyprus	13201	28763	0.03	0.06	0.41	0.29	$1,055	$5,653	$4,598	**25.5%**	**42.6%**	**31.9%**
Denmark	38216	73115	0.07	0.08	0.25	0.28	$10,142	$20,135	$9,993	**-17.3%**	**94.6%**	**22.7%**
Estonia	4822	14409	0.06	0.05	0.33	0.22	$812	$2,986	$2,173	**38.9%**	**78.9%**	**-17.8%**
Finland	40367	56256	0.06	0.06	0.29	0.26	$8,218	$12,685	$4,468	**22.6%**	**75.9%**	**1.5%**
France	33460	54511	0.05	0.05	0.31	0.28	$5,543	$9,867	$4,324	**13.5%**	**84.1%**	**2.4%**
Greece	14103	32219	0.02	0.03	0.29	0.21	$1,136	$4,183	$3,047	**27.4%**	**58.9%**	**13.7%**
Hungary	4586	15032	0.06	0.05	0.30	0.23	$832	$3,585	$2,752	**25.6%**	**76.5%**	**-2.0%**
Iceland	37538	80018	0.04	0.07	0.39	0.33	$4,018	$17,303	$13,285	**12.1%**	**50.1%**	**37.8%**
Ireland	20421	59972	0.05	0.05	0.45	0.30	$2,442	$10,359	$7,917	**34.8%**	**67.8%**	**-2.6%**
Italy	28750	45669	0.03	0.04	0.24	0.21	$3,741	$8,929	$5,188	**13.9%**	**52.3%**	**33.8%**
Kyrgyz Republic	1053	733	0.07	0.05	0.65	0.50	$118	$70	-$48	**-52.5%**	**69.1%**	**83.4%**
Latvia	4176	9987	0.03	0.06	0.32	0.21	$448	$2,647	$2,199	**31.0%**	**43.2%**	**25.7%**
Luxembourg	45447	99229	0.04	0.04	0.25	0.27	$6,366	$13,469	$7,103	**-12.4%**	**104.3%**	**8.1%**
Netherlands	28400	57820	0.06	0.05	0.26	0.27	$6,038	$10,309	$4,270	**-5.1%**	**134.2%**	**-29.1%**
Norway	41611	99889	0.06	0.06	0.29	0.30	$8,949	$21,681	$12,733	**-2.3%**	**98.9%**	**3.4%**
Poland	2251	11063	0.05	0.05	0.39	0.23	$311	$2,537	$2,226	**36.2%**	**64.1%**	**-0.3%**
Portugal	11371	25597	0.04	0.05	0.31	0.23	$1,433	$6,009	$4,576	**23.9%**	**52.6%**	**23.6%**
Romania	2490	6514	0.03	0.03	0.36	0.23	$193	$983	$789	**36.0%**	**51.4%**	**12.6%**
Spain	19974	37354	0.04	0.04	0.30	0.21	$2,612	$6,933	$4,321	**39.2%**	**60.0%**	**0.8%**
Sweden	43890	61881	0.07	0.07	0.28	0.27	$11,101	$16,662	$5,560	**12.0%**	**84.4%**	**3.6%**
Switzerland	53201	80693	0.04	0.05	0.25	0.24	$9,296	$16,459	$7,163	**8.5%**	**72.5%**	**19.1%**
Tajikistan	935	604	0.09	0.03	0.81	0.70	$102	$28	-$74	**-13.4%**	**35.2%**	**78.2%**
Turkey	4417	10212	0.02	0.04	0.60	0.43	$139	$868	$728	**23.9%**	**42.1%**	**34.0%**
Ukraine	2417	2610	0.04	0.04	0.32	0.21	$302	$543	$241	**73.9%**	**12.2%**	**13.9%**
United Kingdom	26268	57703	0.05	0.05	0.29	0.27	$4,209	$10,644	$6,435	**7.7%**	**83.8%**	**8.4%**
***Europe & Central Asia*[2]**	***20379***	***39322***	***0.05***	***0.05***	***0.35***	***0.28***	***$3,518***	***$8,006***	***$4,488***	***26.2%***	***68.1%***	***5.6%***

Appendix Table 4.1. Global Trends & Sources of Change in Educational Resources per Child, 1990-2005 (continued)

Argentina	6862	7182	0.01	0.04	0.50	0.41	$147	$692	$546	**15.6%**	**3.4%**	**81.0%**
Barbados	9920	16152	0.06	0.07	0.36	0.26	$1,737	$4,298	$2,560	**39.7%**	**50.6%**	**9.8%**
Belize	4085	5899	0.05	0.05	0.83	0.65	$224	$462	$238	**35.0%**	**49.1%**	**15.9%**
Bolivia	1255	2084	0.04	0.06	0.74	0.66	$60	$199	$139	**10.2%**	**41.9%**	**47.8%**
Brazil	4987	6976	0.05	0.04	0.59	0.42	$395	$746	$351	**56.6%**	**49.9%**	**-6.5%**
Chile	3536	9870	0.03	0.03	0.47	0.37	$196	$928	$732	**18.3%**	**61.7%**	**20.0%**
Colombia	1948	5057	0.02	0.05	0.62	0.48	$72	$520	$447	**17.3%**	**45.1%**	**37.6%**
Costa Rica	3930	6733	0.04	0.04	0.61	0.43	$282	$634	$353	**45.8%**	**62.7%**	**-8.5%**
Dominican Republic	1605	5519	0.01	0.02	0.67	0.54	$27	$224	$197	**14.1%**	**53.6%**	**32.3%**
Ecuador	1566	4388	0.03	0.01	0.68	0.53	$65	$114	$49	**57.5%**	**229.1%**	**-186.6%**
El Salvador	1619	4670	0.03	0.03	0.75	0.60	$65	$215	$150	**21.5%**	**86.3%**	**-7.8%**
Guatemala	1641	4032	0.01	0.02	0.89	0.82	$23	$77	$54	**7.1%**	**73.2%**	**19.7%**
Guyana	624	1541	0.06	0.08	0.62	0.49	$57	$241	$184	**20.0%**	**58.9%**	**21.1%**
Haiti	752	816	0.01	0.01	0.81	0.66	$14	$18	$5	**72.8%**	**27.2%**	**0.0%**
Honduras	1118	2405	0.04	0.04	0.89	0.71	$51	$120	$69	**28.8%**	**87.7%**	**-16.4%**
Jamaica	3022	6492	0.05	0.05	0.61	0.52	$230	$680	$450	**17.6%**	**68.1%**	**14.2%**
Mexico	5344	12725	0.02	0.05	0.67	0.48	$184	$1,440	$1,256	**22.3%**	**39.1%**	**38.6%**
Nicaragua	469	1490	0.04	0.03	0.90	0.65	$19	$68	$49	**31.3%**	**85.9%**	**-17.2%**
Panama	3501	6972	0.05	0.04	0.59	0.48	$286	$646	$360	**27.8%**	**82.8%**	**-10.6%**
Paraguay	2338	2136	0.01	0.04	0.76	0.60	$35	$137	$103	**20.4%**	**-7.7%**	**87.3%**
Peru	2029	4260	0.03	0.03	0.66	0.51	$83	$227	$144	**29.2%**	**70.2%**	**0.5%**
St. Lucia	4923	7559	0.05	0.05	0.65	0.44	$402	$917	$515	**51.2%**	**48.2%**	**0.6%**
St. Vincent and the Grenadines	3119	5844	0.05	0.06	0.68	0.44	$224	$763	$539	**40.2%**	**46.0%**	**13.8%**
Trinidad and Tobago	6338	15140	0.04	0.04	0.57	0.31	$409	$1,984	$1,576	**49.5%**	**45.1%**	**5.5%**
Uruguay	4627	8138	0.03	0.03	0.42	0.38	$313	$568	$255	**16.7%**	**94.6%**	**-11.3%**
Venezuela, RB	4020	8462	0.03	0.04	0.65	0.49	$160	$749	$589	**22.5%**	**45.0%**	**32.5%**
Latin America & Caribbean[3]	***3276***	***6252***	***0.03***	***0.04***	***0.66***	***0.51***	***$221***	***$680***	***$458***	***26.0%***	***55.6%***	***18.4%***
Algeria	4444	4499	0.05	0.04	0.81	0.45	$273	$446	$173	**116.1%**	**2.2%**	**-18.2%**
Bahrain	10837	25755	0.05	0.04	0.47	0.39	$1,079	$2,855	$1,775	**21.5%**	**87.5%**	**-9.0%**
Egypt, Arab Rep.	1347	1865	0.03	0.04	0.78	0.54	$57	$153	$97	**42.0%**	**30.5%**	**27.5%**
Iran, Islamic Rep.	4111	3979	0.03	0.05	0.87	0.39	$161	$466	$305	**82.0%**	**-2.5%**	**20.5%**
Israel	18447	30641	0.06	0.06	0.52	0.45	$2,104	$4,109	$2,005	**24.1%**	**74.6%**	**1.3%**
Jordan	2400	4055	0.06	0.06	0.94	0.63	$160	$363	$202	**53.7%**	**59.8%**	**-13.6%**
Kuwait	19468	47477	0.03	0.04	0.59	0.32	$1,145	$5,898	$4,754	**47.8%**	**44.4%**	**7.9%**
Malta	10447	20178	0.04	0.05	0.36	0.25	$1,114	$3,740	$2,626	**33.3%**	**50.1%**	**16.6%**
Morocco	1822	3023	0.05	0.06	0.71	0.47	$128	$365	$236	**43.7%**	**44.3%**	**12.0%**
Oman	11446	18031	0.03	0.03	0.82	0.53	$452	$1,102	$650	**52.5%**	**46.6%**	**0.9%**
Saudi Arabia	13650	22148	0.06	0.07	0.75	0.55	$1,036	$2,889	$1,854	**33.5%**	**44.4%**	**22.0%**
Syrian Arab Republic	1920	2384	0.04	0.03	0.99	0.61	$83	$101	$18	**265.5%**	**113.5%**	**-279.0%**
Tunisia	2542	4024	0.05	0.07	0.66	0.38	$208	$708	$500	**52.7%**	**32.3%**	**15.0%**
Middle East & North Africa[4]	***7914***	***14466***	***0.05***	***0.05***	***0.71***	***0.46***	***$615***	***$1,784***	***$1,169***	***45.4%***	***49.0%***	***5.6%***
Canada	29710	49794	0.07	0.05	0.30	0.25	$6,720	$9,360	$2,639	**57.6%**	**163.3%**	**-120.9%**
United States	34787	63018	0.05	0.05	0.33	0.31	$5,012	$9,677	$4,665	**8.7%**	**89.9%**	**1.4%**
North America[5]	***32248***	***56406***	***0.06***	***0.05***	***0.32***	***0.28***	***$5,866***	***$9,518***	***$3,652***	***24.5%***	***118.5%***	***-43.1%***

Appendix Table 4.1. Global Trends & Sources of Change in Educational Resources per Child, 1990-2005 (continued)

Bangladesh	493	662	0.01	0.02	0.80	0.54	$7	$21	$14	**41.0%**	**26.0%**	**33.0%**
India	632	1179	0.04	0.03	0.65	0.53	$38	$72	$34	**33.6%**	**97.1%**	**-30.7%**
Nepal	350	526	0.02	0.02	0.78	0.68	$9	$18	$10	**19.6%**	**54.2%**	**26.3%**
Pakistan	731	1245	0.02	0.02	0.82	0.67	$19	$32	$13	**43.0%**	**105.7%**	**-48.7%**
Sri Lanka	745	1787	0.02	0.03	0.51	0.36	$28	$127	$99	**28.8%**	**52.6%**	**18.6%**
South Asia [6]	***590***	***1080***	***0.02***	***0.02***	***0.71***	***0.56***	***$20***	***$54***	***$34***	***30.3%***	***64.9%***	***4.8%***
Angola	1545	3120	0.04	0.03	0.95	0.90	$72	$102	$31	**16.3%**	**206.3%**	**-122.6%**
Benin	740	1019	0.03	0.04	0.89	0.82	$27	$45	$18	**17.0%**	**63.5%**	**19.4%**
Botswana	5148	8580	0.05	0.08	0.86	0.57	$307	$1,268	$961	**34.2%**	**33.2%**	**32.6%**
Burkina Faso	697	745	0.03	0.04	0.95	0.88	$20	$36	$16	**12.7%**	**11.5%**	**75.9%**
Burundi	381	189	0.03	0.05	0.88	0.74	$14	$13	-$1	**-122.9%**	**549.2%**	**-326.3%**
Cameroon	1706	1655	0.03	0.03	0.89	0.76	$59	$63	$4	**228.8%**	**-45.6%**	**-83.3%**
Cape Verde	1988	3630	0.03	0.06	0.98	0.70	$68	$307	$240	**27.0%**	**37.3%**	**35.7%**
Central African Republic	920	589	0.02	0.02	0.81	0.76	$24	$12	-$12	**-10.2%**	**65.4%**	**44.8%**
Chad	556	936	0.01	0.01	0.91	0.90	$8	$12	$5	**1.5%**	**108.7%**	**-10.2%**
Comoros	1128	1094	0.04	0.04	0.91	0.66	$49	$70	$21	**91.3%**	**-8.3%**	**17.0%**
Congo, Dem. Rep.	451	234	0.01	0.01	0.94	0.96	$5	$2	-$2	**3.0%**	**97.0%**	**0.0%**
Congo, Rep.	1818	2401	0.07	0.02	0.84	0.75	$145	$72	-$73	**-16.3%**	**-42.5%**	**158.7%**
Cote d'Ivoire	1389	1475	0.07	0.05	0.85	0.75	$114	$92	-$22	**-56.9%**	**-27.4%**	**184.3%**
Ethiopia	478	315	0.03	0.02	0.87	0.86	$15	$9	-$7	**-1.1%**	**71.5%**	**29.6%**
Gambia, The	599	504	0.03	0.02	0.79	0.79	$24	$13	-$11	**-0.4%**	**28.3%**	**72.1%**
Ghana	729	845	0.03	0.05	0.83	0.70	$25	$57	$33	**23.0%**	**17.8%**	**59.2%**
Guinea	785	651	0.02	0.02	0.85	0.81	$17	$16	-$1	**-162.9%**	**584.5%**	**-321.6%**
Kenya	725	967	0.06	0.06	1.01	0.78	$45	$78	$33	**48.3%**	**51.0%**	**0.7%**
Lesotho	1154	1539	0.04	0.10	0.89	0.73	$55	$203	$148	**17.5%**	**22.5%**	**60.0%**
Madagascar	503	535	0.02	0.03	0.86	0.84	$12	$17	$6	**5.2%**	**16.0%**	**78.8%**
Malawi	385	424	0.03	0.04	0.92	0.93	$11	$16	$5	**-2.3%**	**24.2%**	**78.1%**
Mali	601	828	0.02	0.04	0.86	0.84	$16	$35	$18	**3.7%**	**42.3%**	**54.0%**
Mauritania	1049	1131	0.05	0.02	0.84	0.72	$56	$35	-$21	**-34.9%**	**-16.2%**	**151.1%**
Mauritius	3372	7348	0.03	0.04	0.44	0.36	$255	$767	$512	**20.1%**	**67.9%**	**12.0%**
Mozambique	341	563	0.04	0.04	0.93	0.84	$14	$28	$14	**16.0%**	**72.4%**	**11.6%**
Niger	634	522	0.03	0.02	1.01	1.00	$20	$12	-$8	**-1.8%**	**37.7%**	**64.0%**
Rwanda	747	477	0.04	0.03	1.02	0.77	$26	$19	-$7	**-93.1%**	**152.8%**	**40.3%**
Sierra Leone	259	412	0.02	0.04	0.77	0.77	$8	$21	$13	**0.1%**	**48.6%**	**51.4%**
South Africa	5294	7892	0.06	0.05	0.67	0.49	$453	$843	$390	**52.7%**	**61.6%**	**-14.3%**
Sudan	795	1175	0.02	0.01	0.83	0.73	$20	$14	-$6	**-35.5%**	**-113.0%**	**248.4%**
Swaziland	2760	4376	0.04	0.06	0.98	0.76	$126	$366	$240	**26.0%**	**41.5%**	**32.5%**
Tanzania	312	685	0.02	0.02	0.89	0.85	$8	$19	$11	**6.4%**	**93.6%**	**0.0%**
Togo	799	625	0.05	0.03	0.90	0.75	$46	$21	-$25	**-25.1%**	**32.2%**	**92.9%**
Uganda	484	652	0.03	0.04	0.98	1.03	$17	$25	$8	**-12.9%**	**76.3%**	**36.6%**
Zambia	738	1129	0.03	0.02	0.89	0.90	$22	$27	$5	**-9.2%**	**213.9%**	**-104.6%**
Zimbabwe	1593	467	0.08	0.07	0.90	0.74	$140	$43	-$97	**-17.7%**	**104.6%**	**13.1%**
Sub-Saharan Africa [7]	***1211***	***1659***	***0.04***	***0.04***	***0.88***	***0.78***	***$65***	***$133***	***$68***	***25.4%***	***66.8%***	***7.8%***

Data Souce: World Bank 2010.

Missing Countires by Region: (1) American Samoa, Cambodia, French Polynesia, Guam, Kiribati, Korea, Dem. Rep., Lao PDR, Macao, China, Marshall Islands, Micronesia, Fed. Sts., Myanmar, New Caledonia, Northern Mariana Islands, Palau, Papua New Guinea, Solomon Islands, Timor-Leste, Vietnam; (2)Albania, Andorra, Armenia, Azerbaijan, Bosnia and Herzegovina, Channel Islands, Croatia, Czech Republic, Faeroe Islands, Georgia, Germany, Greenland, Isle of Man, Kazakhstan, Liechtenstein, Lithuania, Macedonia, FYR, Moldova, Monaco, Montenegro, Russian Federation, San Marino, Serbia, Slovak Republic, Slovenia, Turkmenistan, Uzbekistan; (3) Antigua and Barbuda, Aruba, Bahamas, Bermuda,The Cayman Islands, Cuba, Dominica, Grenada, Netherlands Antilles, Puerto Rico, St. Kitts and Nevis, Suriname, Virgin Islands (U.S.); (4) Djibouti, Iraq, Lebanon, Libya, Qatar, United Arab Emirates, West Bank and Gaza, Yemen, Rep.; (6) Afghanistan, Bhutan, Maldives; (7)Equatorial Guinea, Eritrea, Gabon, Guinea-Bissau, Liberia, Mayotte, Namibia, Nigeria, Sao Tome and Principe, Senegal, Seychelles, Somalia

REFERENCES

Ainsworth, M. 1992. *Economic aspects of child fostering in Côte d'Ivoire*. World Bank.

Akinrinola, B., and S. Singh. 1997. "Couples' fertility and contraceptive decision making in developing countries: Hearing the man's voice." *International Family Planning Perspectives* 24:15–24.

Akresh, R. 2005. *Risk, network quality, and family structure: child fostering decisions in Burkina Faso*. Economic Growth Center, Yale University.

Allison, P. 1999. *Logistic regression using the SAS system: theory and application*. SAS Publishing.

Angrist, J., V. Lavy, and A. Schlosser. 2005. *New evidence on the causal link between the quantity and quality of children*. National Bureau of Economic Research Cambridge, Mass., USA.

Anh, T., J. Knodel, D. Lam, and J. Friedman. 1998. "Family size and children's education in Vietnam." *Demography* 35:57-70.

Ashford, L. S. 2007. "Africa's youthful population: Risk or Opportunity." *Population Reference Bureau, Washington DC*.

Bankole, A., and S. Singh. 1998. "Couples' fertility and contraceptive decision-making in developing countries: hearing the man's voice." *International Family Planning Perspectives* 24:15–24.

Bankole, A., and C. F. Westoff. 1995. *Childbearing attitudes and intentions*. Macro International, Inc.

Barro, R. J. 1991. "Economic growth in a cross section of countries." *The Quarterly Journal of Economics* 106:407 -443.

Becker, G. S., and H. G. Lewis. 1973. "On the interaction between the quality and quantity of children." *Journal of political Economy* 81:S279–S288.

Becker, G. S. 1964. *Human capital: a theoretical and empirical analysis, with special reference to education*. University of Chicago Press.

Behrman, J., N. Birdsall, and R. Kaplan. 1996. "The quality of schooling and labor market outcomes." *Opportunity Foregone: Education in Brazil*. Washington, D.C.: Inter-American Development Bank.

Behrman, J. R., and N. Birdsall. 1983. *The quality of schooling: quantity alone is misleading*. Washington, D.C.: World Bank.

Bernard, H. R. 2000. *Social research methods: qualitative and quantitative approaches*. SAGE Publications.

Bhat, P. N.M. 2002. *Demographic transition, family size and child schooling*. National Council of Applied Economic Research.

Birdsall, N., A. C. Kelley, and S. W. Sinding. 2001. *Population matters: demographic change, economic growth, and poverty in the developing world*. Oxford University Press.

Black, S. E., P. J. Devereux, and K. G. Salvanes. 2005. "The more the merrier? The effect of family size and birth order on children's education*." *Quarterly Journal of Economics* 120:669–700.

Blake, J. 1989. *Family size and achievement*. University of California Press Los Angeles.

Blake, J. 1981. "Family size and the quality of children." *Demography* 18:421–442.

Blau, P. M., and O. D. Duncan. 1967. *The American occupational structure.* New York: John Wiley.

Bloom, D. E, D. Canning, and J. Sevilla. 2003. *The demographic dividend: A new perspective on the economic consequences of population change*. Santa Monica: Rand Corp.

Bongaarts, J. 2008. "Fertility transitions in developing countries: Progress or stagnation?" *Studies in Family Planning* 39:105–110.

Bongaarts, J. 2006. "The causes of stalling fertility transitions." *Studies in Family Planning* 37:1–16.

Bongaarts, J. 2003. "Completing the fertility transition in the developing world: The role of educational differences and fertility preferences." *Population Studies* 57:321–335.

Bongaarts, J. 1997. "Trends in Unwanted Childbearing in the Developing World." *Studies in Family Planning* 28:267-277.

Bongaarts, J. 1995. *The role of family planning programs in contemporary fertility transitions*. New York: Population Council, Research Division.

Bronars, S. G., and J. Grogger. 1994. "The economic consequences of unwed motherhood: Using twin births as a natural experiment." *The American Economic Review* 84:1141–1156.

Buchmann, C. 2002. "Getting ahead in Kenya: Social capital, shadow education, and achievement." *Research in Sociology of Education* 13:135–161.

Buchmann, C. 2000. “Family Structure, parental perceptions and child labor in Kenya: What factors determine who is enrolled in school.” *Social Forces* 78:1349.

Buchmann, C., and B. Dalton. 2002. “Interpersonal influences and educational aspirations in 12 countries: the importance of institutional context.” *Sociology of Education* 75:99–122.

Burnside, C., and D. Dollar. 2000. “Aid, policies, and growth.” *The American Economic Review* 90:847–868.

Caldwell, J. C. 1997. “The global fertility transition: The need for a unifying theory.” *Population and Development Review* 23:803–812.

Caldwell, J. C., and P. Caldwell. 1987. “The cultural context of high fertility in sub-Saharan Africa.” *Population and Development Review* 13:409–437.

Case, A., C. Paxson, and J. Ableidinger. 2004. “Orphans in Africa: parental death, poverty, and school enrollment.” *Demography* 41:483–508.

Cassen, R. 1994. *Population and development: Old debates, new conclusions*. New Brunswick: Transaction Publishers.

Chen, S., and M. Ravallion. 2008. “The developing world Is poorer than we thought, but no less successful in the fight against poverty.” *SSRN eLibrary*. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1259575 (Accessed May 2, 2011).

Chernichovsky, D. 1985. “Socioeconomic and demographic aspects of school enrollment and attendance in rural Botswana.” *Economic Development and Cultural Change* 33:319.

Conley, D., and R. Glauber. 2005. *Parental educational investment and children's academic risk: Estimates of the impact of sibship size and birth order from exogenous variations in fertility*. National Bureau of Economic Research Working Paper No. 11302.

Courade, M. 1994. *Le village Camerounais à l'heure de l'ajustement*. Paris: Karthala.

Crenshaw, E. M., A. Z. Ameen, and M. Christenson. 1997. “Population dynamics and economic development: Age-specific population growth rates and economic growth in developing countries, 1965 to 1990.” *American Sociological Review* 62: 974–984.

Demographic Health Surveys (DHS). 2010. “Demographic Health Survey Data.” http://www.measuredhs.com/.

Denison, E. 1962. “United States economic growth.” *Journal of Business* 35:357-394.

DeRose, L. F., and O. Kravdal. 2007. “The effects of educational reversals on first births in sub-Saharan Africa: A dynamic multi-level perspective.” *Demography* 44:59–77.

Desai, S. 1995. "When are children from large families disadvantaged? Evidence from cross-national analyses." *Population Studies: A Journal of Demography* 49:195.

Diamond, I., M. Newby, and S. Varle. 1999. "Female education and fertility: Examining the links." Pp. 23-45 in *Critical perspectives on schooling and fertility in the developing world*, edited by Caroline H. Bledsoe and National Research Council (U.S.). Committee on Population: National Academies Press.

Dodoo, F. N.A. 1998. "Men matter: additive and interactive gendered preferences and reproductive behavior in Kenya." *Demography* 35:229–242.

Downey, D. B. 1995. "When bigger is not better: Family size, parental resources, and children's educational performance." *American Sociological Review* 60:746–761.

Easterly, W., R. Levine, and D. Roodman. 2004. "Aid, policies, and growth: comment." *The American Economic Review* 94:774–780.

Eastwood, R., and M. Lipton. 2001. "Demographic transition and poverty: Effects via economic growth, distribution, and conversion.." Pp. 213-259 in *Population matters: Demographic change, economic growth, and poverty in the developing world*, edited by N Birdsall, A. C. Kelley, and S. W. Sinding. Oxford: Oxford University Press.

Eloundou-Enyegue, P., and J. DaVanzo. 2001. "Economic downturns and schooling inequality, Cameroon, 1987-95." *Population Studies* 57:183–197.

Eloundou-Enyegue, P.M. and S. Giroux. 2010. *Comprendre le changement social: Apport des methodes des decomposition.* Yaoude, Cameroon: IFORD.

Eloundou-Enyegue, P.M. and S. Giroux. "Fertility transitions and schooling: From micro to macro-level associations". Forthcoming in *Demography.*

Eloundou-Enyegue, P. M, C. S. Stokes, and G. T. Cornwell. 2000. "Are there crisis-led fertility declines? Evidence from central Cameroon." *Population Research and Policy Review* 19:47–72.

Eloundou-Enyegue, P. M., and L. B. Williams. 2006. "Family size and schooling in Sub-Saharan African settings: A reexamination." *Demography* 43:25-52.

Ezeh, A., M. Seroussi, and M. Raggers. 1996. *Men's fertility, contraceptive Uue, and reproductive preferences*. Demographic Health Surveys Macro.

Finkle, J. 1994. "Impact of the 1994 Conference on Population and Development." www.un.org/esa/population/publications/.../RevisedFINKLEpaper.PDF.

Firebaugh, G. 1999. “Empirics of world income inequality.” *American Journal of Sociology* 104:1597–1630.

Firebaugh, G., and B. Goesling. 2004. “Accounting for the recent decline in global income inequality.” *American Journal of Sociology* 283–312.

Fleshman, M. 2010. “Abolishing fees boosts African schooling.” *Africa Renewal*, January, 16.

Gerke, S. 2000. “6 Global Lifestyles under Local Conditions: the New Indonesian Middle Class.” *Consumption in Asia: Lifestyles and Identities* 135.

Giroux, S. C. 2008. “Rural parentage and labor market disadvantage in a sub-Saharan setting: Sources and trends.” *Rural Sociology* 73:339–369.

Giroux, S. C., P. M. Eloundou-Enyegue, and D. T. Lichter. 2008. “Reproductive Inequality in Sub-Saharan Africa: Differentials versus Concentration.” *Studies in Family Planning* 39:187–198.

Glewwe, P., and J. Desai. 1999. *The economics of school quality investments in developing countries: An empirical study of Ghana*. New York: St. Martin's Press.

Greene, M. E, and T. Merrick. 2005. “Poverty reduction: does reproductive health matter.” *Health, Nutrition and Population Discussion Paper.* Washington: The World Bank.

Guo, G., and L. K. VanWey. 1999. “Sibship size and intellectual development: Is the relationship causal?.” *American Sociological Review* 64:169–187.

Halsey, R. 2010. “The decision to invest in child quality over quantity: Declining fertility and rising household investment in education in Vietnam.” PopPov 4th Annual Conference, Cape Town, South Africa. http://poppov.org/Portals/1/documents/events/4thAnnConf/rogers.pdf.

Hannum, E., and C. Buchmann. 2005. “Global educational expansion and socio-economic development: An assessment of findings from the social sciences.” *World Development* 33:333–354.

Hausman, J. A. 1983. “Specification and estimation of simultaneous equation models.” *Handbook of Econometrics* 1:391–448.

Hewitt, P. 2004. “NOVA World in Balance Interviews: Paul Hewitt.” http://www.pbs.org/wgbh/nova/worldbalance/voic-hewi.html.

Jacobsen, J. P, J. W. Pearce, and J. L. Rosenbloom. 1999. “The effects of childbearing on married women's labor supply and earnings: using twin births as a natural experiment.” *The Journal of Human Resources* 34:449–474.

Kanbur, R. 2006. "What's Social Policy Got to do with Economic Growth?" Deparment of Applied Economics and Management Working Paper WP2006-05.

Kandiwa, V. 2006. "Hegemony and Homogeneity." *The Current* 10:1.

Kasarda, J. D., and E. M. Crenshaw. 1991. "Third world urbanization: dimensions, theories, and determinants." *Annual Review of Sociology* 17:467–501.

King, E. 1987. "The effect of family size on welfare." in *Population growth and economic development: Issues and evidence*, edited by D.G. Johnson and R. Lee. Madison: University of Wisconsin Press.

Kirk, D., and B. Pillet. 1998. "Fertility levels, trends, and differentials in sub-Saharan Africa in the 1980s and 1990s." *Studies in Family Planning* 29:1–22.

Knodel, J. N. Havanon, and W. Sittitrai. 1990. "Family Size and the Education of Children in the Context of Rapid Fertility Decline." *Population and Development Review* 16:31-62.

Kuo, H.D., and R. M. Hauser. 1997. "How does size of sibship Matter? Family configuration and family effects on educational attainment." *Social Science Research* 26:69–94.

Lam, D., and L. Marteleto. 2008. "Stages of the demographic transition from a child's perspective: family size, cohort size, and children's resources." *Population and Development Review* 34:225–252.

Lee, J. 2008. "Sibling size and investment in children's education: An Asian instrument." *Journal of Population Economics* 21:855–875.

Lesthaeghe, R. J. 1989. *Reproduction and social organization in Sub-Saharan Africa*. University of California Press.

Levine, R., and S. J. Zervos. 1993. "What we have learned about policy and growth from cross-country regressions?." *The American Economic Review* 83:426–430.

Lloyd, C. B. 2005. *Growing up global: The changing transitions to adulthood in developing countries*. Washington, D.C.: National Academies Press.

Lloyd, C. B. 1994. *Investing in the next generation: the implications of high fertility at the level of the family*. New York: Population Council.

Lloyd, C. B., and A. K. Blanc. 1996. "Children's schooling in sub-Saharan Africa: The role of fathers, mothers, and others." *Population and Development Review* 22:265-298.

Lloyd, C. B, and A. J. Gage-Brandon. 1994. "High fertility and children's schooling in Ghana: Sex differences in parental contributions and educational outcomes." *Population Studies* 48:293–306.

Lloyd, C. B, and P. Hewett. 2009. "Educational inequalities in the midst of persistent poverty: Diversity across Africa in educational outcomes." *Journal of International Development* 21:1137–1151.

Lloyd, C. B, B. S. Mensch, and W. H. Clark. 2000. "The effects of primary school quality on school dropout among Kenyan girls and boys." *Comparative Education Review* 113–147.

Lloyd, C. B, C. Mete, and Z. A Sathar. 2005. "The effect of gender differences in primary school access, type, and quality on the decision to enroll in rural Pakistan." *Economic Development and Cultural Change* 53:685–710.

Lloyd, C. B, and S. Desai. 1992. "Children's living arrangements in developing countries." *Population Research and Policy Review* 11:193–216.

Lu, Yao, and Donald J. Treiman. 2008. "The Effect of sibship size on educational attainment in China: Period variations." *American Sociological Review* 73:813-834.

Luke, D. A. 2005. "Getting the big picture in community science: Methods that capture context." *American Journal of Community Psychology* 35:185–200.

Maralani, V. 2008. "The changing relationship between family size and educational attainment over the course of socioeconomic development: Evidence from Indonesia." *Demography* 45:693–717.

Mare, R. D., and M. S. Tzeng. 1989. "Fathers' ages and the social stratification of sons." *The American Journal of Sociology* 95:108–131.

Marjoribanks, K. "Academic achievement: Family size and social class correlates." in *Environments for learning*, edited by K. Marjoribanks. Windsor, England: NFER Publishing.

Marteleto, L. 1996. "Children's schooling in Brazil: do number and composition of siblings matter?" *Population and Development Review* 22:47–75.

Mason, A., and S. H. Lee. 2004. "The demographic dividend and poverty reduction." Pp. 17–19 in *Seminar on the relevance of population aspects for the achievement of the millennium development goals New York*.

Mogstad, M., and M. Wiswall. 2010. *Testing the Quantity-Quality Model of Fertility: Linearity, Marginal Effects, and Total Effects*. Working Paper. homepages.nyu.edu/~mw109/mogstad_wiswall_family_size_2010.pdf

Montgomery, M., and A. Kouame. 1993. *Fertility and child schooling in Côte d'Ivoire: Is there a tradeoff?* Washington D.C., World Bank-Africa Technical Deptartment Human Resources and Poverty Division.

Montgomery, M., A. Kouame, and R. Oliver. 1995. *The tradeoff between number of children and child schooling: evidence from Côte d'Ivoire and Ghana*. Washington D.C., World Bank.

Montgomery, M. R., and C. B. Lloyd. 1999. "Excess fertility, unintended births, and children's schooling." Pp. 216–266 in *Critical perspectives on schooling and fertility in the developing world*, edited by C. Bledsoe. U.K.: National Research Council.

National Research Council (NRC). 1986. *Population growth and economic development: Policy questions*. Washington, D.C.: National Academy Press.

Norton, E. C., H. Wang, and C. Ai. 2004. "Computing interaction effects and standard errors in logit and probit models." *Stata Journal* 4:154–167.

Parish, W. L., and R. J. Willis. 1993. "Daughters, education, and family budgets Taiwan experiences." *The Journal of Human Resources* 28:863–898.

Pearl, J. 2000. *Causality: models, reasoning, and inference*. Cambridge University Press.

Pong, S.L. 1997. "Sibship size and educational attainment in peninsular Malaysia: Do policies matter?" *Sociological Perspectives* 40:227-242.

Psacharopoulos, G., and H. A. Patrinos. 2004. "Returns to investment in education: a further update." *Education Economics* 12:111–134.

Radhakrishnan, S. 2008. "Examining the "Global" Indian middle class: Gender and culture in the Silicon Valley/Bangalore circuit." *Journal of Intercultural Studies* 29:7–20.

Roberts, B. R. 1989. "Urbanization, migration, and development." *Sociological Forum* 4: 665–691.

Robles, A. 2005. "Age structure, labor force and education in Costa Rica." International Union for the Scientific Study of Population Annual Meeting, Tours, France. iussp2005.princeton.edu/download.aspx?submissionId=52009.

Rodrik, D. 2005. "Why we learn nothing from regressing economic growth on policies." *Harvard University*. www.international.ucla.edu/cms/files/rodrik.pdf.

Rodgers, H. 2010. "Child quality over quantity." POPPOV Conference Presentation. Cape Town South Africa

Rosenzweig, M. R., and K. I. Wolpin. 1980. "Testing the quantity-quality fertility model: the use of twins as a natural experiment." *Econometrica: Journal of the Econometric Society* 227–240.

Rosenzweig, M. R., and J. Zhang. 2009. "Do population control policies induce more human aapital investment? Twins, birth weight and China's "One-child" policy." *Review of Economic Studies* 76:1149–1174.

Ross, J. 2004. *Understanding the demographic dividend*. Washington, D.C.: Policy Project www.policyproject.com/pubs/generalreport/Demo_Div.pdf.

Sahn, D. E., and D. C. Stifel. 2003. "Progress toward the millennium development goals in Africa." *World Development* 31:23–52.

Schultz, T. P. 2005. "Effects of fertility decline on family well being: Opportunities for evaluating population programs." Working Paper. www.econ.yale.edu/~pschultz/Fertility%20decline%203-15-05.pdf.

Sewell, W. H., R. M. Hauser, and W. C. Wolf. 1980. "Sex, schooling, and occupational status." *The American Journal of Sociology* 86:551–583.

Shapiro, D., and T. Gebreselassie. 2008. "Fertility transition in sub-Saharan Africa: Falling and stalling." *Afr. Popul. Stud* 23:3–23.

Shapiro, D., and B. Tambashe. 2002. "Fertility transition in urban and rural Sub -Saharan Africa: Preliminary evidence of a three-Stage Process." *African Population Studies* 8:103-127.

Short, S. E., and G. E. Kiros. 2002. "Husbands, wives, sons, and daughters: Fertility preferences and the demand for contraception in Ethiopia." *Population Research and Policy Review* 21:377–402.

Spenner, K. I, and D. L Featherman. 1978. "Achievement ambitions." *Annual Review of Sociology* 4:373–420.

Steelman, L. C., B. Powell, R. Werum, and S. Carter. 2002. "Reconsidering the effects of sibling configuration: recent advances and challenges." *Annual Review of Sociology* 243–270.

Sudha, S. 1997. "Family size, sex composition and children's education: Ethnic differentials over development in Peninsular Malaysia." *Population Studies* 51:139–151.

Stokes, C. S. 1995. "Explaining the demographic transition: Institutional factors in fertility decline." *Rural Sociology* 60:1–2

Thornton, A. 2001. "The developmental paradigm, reading history sideways, and family change." *Demography* 38:449–465.

UNICEF. 2008. *The state of the world's children 2008*. New York: United Nations UNICEF.

UNICEF. 2006. *The state of the world's children 2006*. New York: United Nations UNICEF.

United Nations. 2011. *World population prospects: The 2010 revision data online.* New York: United Nations Department of Economic and Social Affairs- Population Division. http://esa.un.org/unpd/wpp/unpp/panel_population.htm

United Nations. 2010. *Progress towards MDGs*. New York: United Nations http://www.undp.org/africa/documents/mdg/full-report.pdf.

United Nations 2010b. *Education for all global monitoring report*. New York: United Nations, Education, Scientific and Cultural Organization http://www.undp.org/africa/documents/mdg/full-report.pdf.

United Nations. 2009. *World contraceptive use 2009*. New York: Department of Economic and Social Affairs Population Division

United Nations. 2008. *The millennium Development Goals Report*. New York: United Nations.

United Nations. 2004a. *World population to 2300*. New York: Department of Economic and Social Affairs Population Division.

United Nations. 2004b. *World urbanization prospects: The 2003 Revision*. New York: Department of Economic and Social Affairs Population Division www.un.org/esa/population/publications/.../WUP2003Report.pdf.

United States State Department (USSD). 2006. *Background note: Cameroon.* http://www.state.gov/r/pa/ei/bgn/26431.htm.

World Bank. 2010. "World Development Indicators Online."

World Bank 2010b. "World Bank Global Statistical Strategy." http://data.worldbank.org/about/data-overview/global-statistical-strategy.

World Bank. 2009. *Youth Unemployment a Major Challenge for African Countries*. Washington, D.C.: World Bank http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/0,,contentMDK:22157069~menuPK:258657~pagePK:2865106~piPK:2865128~theSitePK:258644,00.html.

Wusu, O., and U. C. Isiugo-Abanihe. 2004. "Family structure and reproductive health decision-making among the Ogu of Southwestern Nigeria: A qualitative study." *African Population Studies* 18:2.

Zuehlke, E. 2009. "Youth unemployment and underemployment in Africa brings uncertainty and ppportunity." Washington, D.C., Population Reference Bureau http://www.prb.org/Articles/2009/youthunemployment.aspx